Concrete

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Reinforced Concrete Design Simplified

This Is the First Article of the Series To Be Published Under This Title—It Shows How the Material To Be Presented Can Be Used—How the Charts Are Constructed—What Stresses Will Be Used

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DURING the writer's varied experience in design, construction, and technical teaching, he has tried to analyze the inherent difficulties of routine concrete design in order to eliminate them as much as possible. These articles present a simplified method for designing reinforced concrete structures that can easily be used by the contractor and the architect as well as by the experienced designer.

For the Experienced Designer

The first problem in the design of any structure is the estimation of cost. As the individual members are a factor in the total cost of any structure, any method whereby the size of these members may be rapidly determined should be of interest to the designer preparing the estimate.

Wrong assumptions as to dead-load weight frequently necessitate a complete revision of that member's computations. Likewise, commercial sizes of both steel and form lumber require revisions which obviate the requirements of extreme accuracy. The rapid determination of member characteristics, both as to the first assumption as well as final design, is a material factor in the reduction of design costs.

The rapid checking of any design is essential not only from the standpoint of cost, but the time element as well. The necessity of an accurate check, however, does not eliminate the monotony of such work.

For the Occasional Designer

An engineer may be perfectly competent to design any structure, but he may be an executive, a salesman, or a maintenance man, for whom actual design is only an occasional issue. The multitude of formulas and requirements of reinforced concrete analysis are particularly troublesome to this type of individual, and he usually welcomes any means of simplification.

For the Construction Engineer

How many times has the average construction engineer wished that the designers knew more of the practical features so as to anticipate and eliminate difficulties? Slight changes of dimensions to save costly ripping of form lumber. Footings offset to avoid obstructions. An overlooked lintel, and a thousand and one details that are so troublesome on any construction job.

This same individual is usually so rusty on his design theory that he must needs resort to more than adequate sections unless some simple, rapid method of design is available.

For the Architect

The writer, during his teaching of reinforced concrete to them as students and his personal contact with them in practice, has observed that the average architect has not only an artistic talent but an inherent dislike for anything mathematical. Although he may be exposed, in college, to an efficient course in concrete design, by the time he is ready to take his state examination for license his concrete theory, from non-use, has completely left him. He is usually delighted with any method that simplifies the many routine design problems occurring in even the smallest building.

For the Contractor

Many of our present-day successful contractors have not had the opportunity of acquiring a technical education except in the university of Hard-Knocks. Yet the intelligent placing of engineering materials, especially concrete, almost necessitates some knowledge as to the theory of design.

The average textbook on any technical subject is far from simple for even a technical student, and must be supplemented by class room explanations. So any simplification, in either presentation or application, of reinforced concrete design theory should be of value to the practical contractor.

Design Theory Simplified

While trying to brush up on forgotten design methods or the presentation of new theories, the writer has found that fully explained sample problems are of incomparable value. Formulas by themselves mean little to those unfamiliar with their application. Likewise, many solution examples remain deep mysteries due to the fact that some explanation has been omitted.

In presenting this series of design problems, every effort will be made to simplify the design theory by working out an example and explaining fully the significance of the various steps.

Joint Committee Specifications

Building codes have not been able to keep pace with the developments of reinforced concrete design theory and as a consquence, each locality may have limitations materially differing from those of all the rest. In an effort to standardize the analysis of reinforced concrete, representatives from each of five organizations met as a joint committee. The organizations represented are: American Society of Civil Engineers, American Society for Testing Materials, American Railway Engineering Association, American Concrete Institute, and Portland Cement Association. They have prepared what is commonly known as "The Joint Committee Specifications." These specifications are fast becoming the accepted standard for reinforced concrete design. Some of the more intelligent city building officials have been far-sighted enough to have a clause inserted in the building code permitting the use of the Joint Committee Specifications in lieu of the code.

While the permissible steel stresses are fixed, depending upon the quality, the concrete stresses are specified as a function of the ultimate, or maximum at failure, stress in the concrete. This requires the designing of a concrete mix in order to obtain the required strength.

Summary of Working Stresses

Ultimate compressive strength of concrete at age of 28 days, based on tests of standard cylinders made and tested in the standard way	$= f'_c$
Direct Stress in Concrete	
Direct Compression	
Columns. (Depends upon amount and type of reinforcing. To be discussed in detail later.)	
Piers and Pedestals	$0.25\,f'_c$
Compression in Extreme Fiber	
In flexure	$0.40\,f'_c$
In flexure adjacent to supports of continuous beams	$0.45\,f'_c$
Tension	none
Shearing Stresses in Concrete	
Longitudinal Bars Without Special Anchorage	
Beams without web reinforcement	$0.02\,f'_c$
Beams with stirrups or bent-up bars or in combination of the two	$0.06\,f'_c$
Footings	$0.02\,f'_c$
Longitudinal Bars with Special Anchorage	
Beams without web reinforcement	$0.03\,f'_c$
Beams with stirrups or bent-up bars or a combination of the two	$0.12\,f'_c$
Footings	$0.03\,f'_c$
Stresses in Reinforcement	
Tension in Steel	Lbs. per Sq. In.
Structural steel	16,000
Intermediate steel	18,000
Hard steel	18,000
Rail-steel	18,000
Cold-drawn wire	18,000
Compression in Steel	
Bars	Same as for tension
Bond Between Concrete and Reinforcement	
Beams and slabs, plain bars	$0.04\,f'_c$
Beams and slabs, deformed bars	$0.05\,f'_c$
Footings, plain bars, one-way	$0.04\,f'_c$
Footings, deformed bars, one-way	$0.05\,f'_c$
Footings, plain bars, two ways	$0.03\,f'_c$
Footings, deformed bars, two ways	$0.0375\,f'_c$

In order to apply the reinforced concrete theory to specific problems, the assumptions will be made that an intermediate grade, plain, steel bar will be used for reinforcing, and that the concrete mix is designed for an ultimate strength of 2,000 pounds per square inch. Thus we have the values:

$f'_c = 2{,}000$ lbs. per sq. in., ultimate concrete strength.
$f'_s = 18{,}000$ lbs. per sq. in., allowable steel stress.

These values have been used as they represent the limiting values of probably the maximum number of readers.

Application Simplified

Further simplification may easily be accomplished by the preparation of graphs, or charts, for the solution of the design formulas. In the series of problems to follow, a chart will accompany each problem. The proposed outline of charts to be presented, representing ultimate simplification, are as follows:

Chart A, Balanced Tensile Reinforcing for Beams
Chart B, Dead-Load Beam Information
Chart C, Choice of Steel for Beams and Columns
Chart D, Diagonal Tension and Shear
Chart E, Stirrup Spacing
Chart F, Portion of Beam Requiring Web Reinforcing
Chart G, Unit Stress in Compressive Steel
Chart H, Area of Compressive Steel for Beams
Chart I, Area of Steel for "T" Beams
Chart J, Concrete Stress in "T" Beams
Chart K, Reinforced Concrete Slabs
Chart L, Choice of Steel for Slabs
Chart M, Spiral Reinforced Column
Chart N, Spiral Reinforced Long Column
Chart O, Column with Lateral Ties.

Charts in General

Due to their simplicity and speed of application, charts and graphs are becoming very popular in almost every line of endeavor. Many organizations have developed charts for the solution of their particular problems, and they often consider these charts highly confidential. In order to justify the time spent on the construction of any chart, the writer feels that the problem should not only be simplified, but the chart made as simple as possible.

The Nomograph

The nomograph, or alinement chart, is generally conceded as being the simplest type of chart in application, requiring but a straight edge across parallel scales, representing values of each variable, for solution. Its application has, however, been somewhat restricted due to the general ignorance of the public as to its requirements in construction. Always searching for a means of further simplification, the writer has developed a means of solving for nomograph characteristics involving but two simple simultaneous equations. Using this method of chart design, the nomograph then becomes the simplest type in construction as well as application.

If three parallel lines are drawn such that the central line is midway between the other two, Fig. 1, with the lines (ab) and (cd) drawn at any position and (ad)

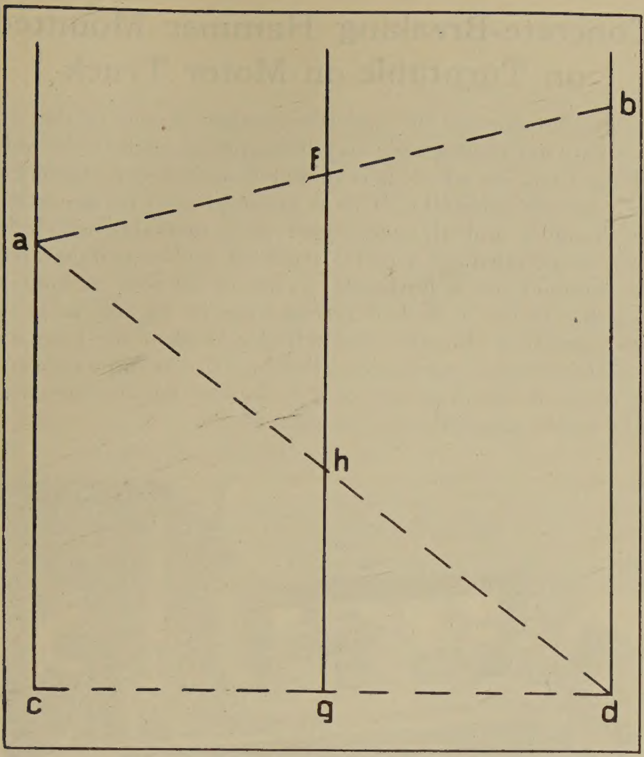


Figure 1

connecting opposite ends, from similar triangles we have the relation:

$$fh = \frac{bd}{2}$$

$$hg = \frac{ac}{2}$$

$$fg = fh + hg = \frac{1}{2}(bd + ad) \qquad \text{Eq. 1}$$

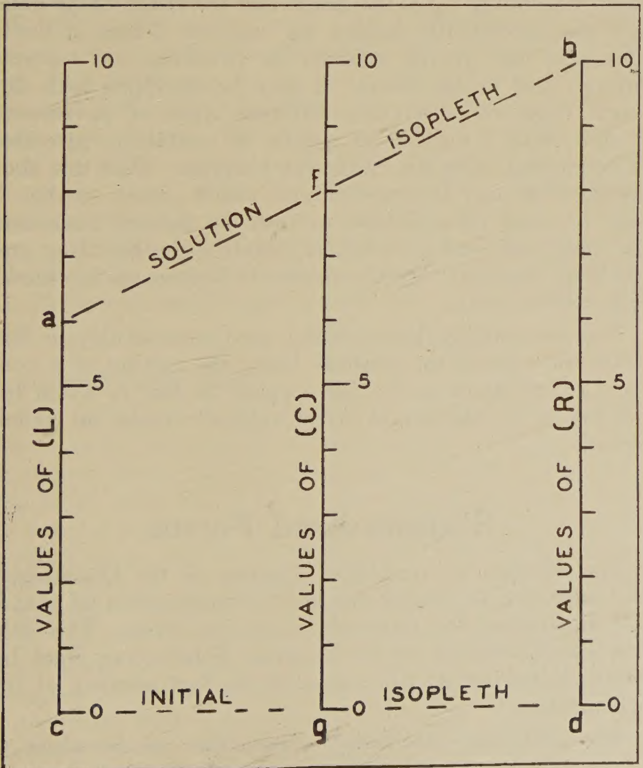


Figure 2

Now, if equal rectangular co-ordinates were laid out on the three parallel lines, Fig. 2, with their origins at the initial isopleth (*cd*), we would have three scales of values; left (*L*), central (*C*), and right, (*R*). Then from Eq. 1 we would obviously have the relations:

$$bd = \mathrm{R}$$

$$ac = \mathrm{L}$$

$$fg = C$$

$$C = \frac{1}{2}(L + R)$$

Likewise, if equal logarithmic co-ordinates were laid out with their origins at the initial isopleth (*cd*), Fig. 3, the

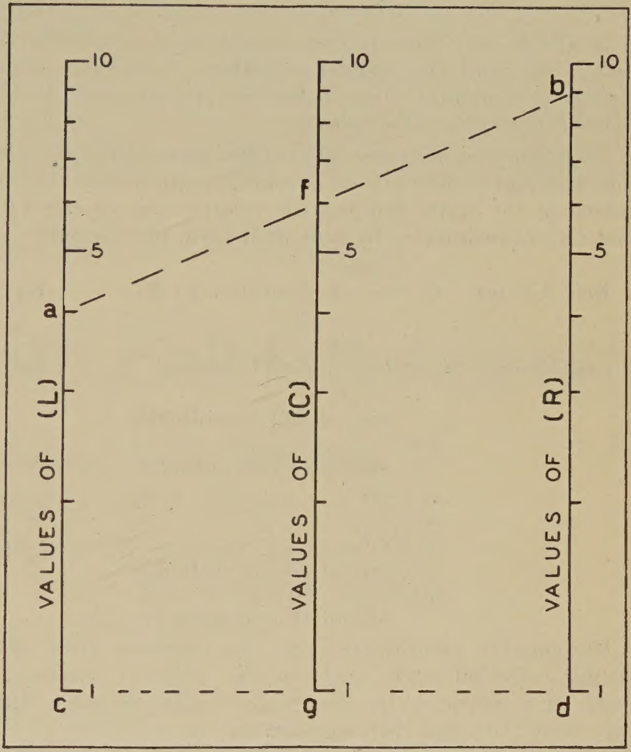


Figure 3

solution isopleth would still give the relation expressed by Eq. 1, but due to the fact that logarithms, rather than numbers, have been laid out, it would give the relation:

$$Log\, C = \frac{1}{2}(Log\, L + Log\, R)$$

or

$$C = (L\,R)^{1/2} = \sqrt{L\,R}$$

Almost any combination of results may be obtained by varying the spacing of the three parallel scales and the relative size of the co-ordinates.

In Fig. 1, we will define the spacing of the scales by the ratio:

$$\frac{gd}{cd} = n$$

from which

$$\frac{cg}{cd} = \frac{cd - gd}{cd} = \frac{cd}{cd} - \frac{gd}{cd} = 1 - n$$

Then for any spacing of the three scales we can write the expressions:

$$fh = (1 - n)\,(bd) \qquad \text{Eq. 2}$$

$$hg = n(ac) \qquad \text{Eq. 3}$$

If equal sized co-ordinates are used on the two outside scales (*L*) and (*R*), the relative size of the co-ordinates on the (C) scale may be defined by the ratio:

$$m = \frac{\text{size of } (R) \text{ co-ordinates}}{\text{size of } (C) \text{ co-ordinates}}$$

Then, for equality between the number of co-ordinates, equations (2) and (3) will become:

$$fh = m(1 - n)\ (bd)$$
$$hg = mn(ac)$$

Thus, for equal rectangular co-ordinates on the two outside scales, we would have the general expression:

$$C = mn\,L + m(1 - n)\ R \qquad \text{Eq. 4}$$

When equal logarithmic co-ordinates are used on the two outside scales, the general expression becomes:

$$C = L^{mn}\ R^{m(1-n)} \qquad \text{Eq. 5}$$

It will be seen that, in these two general equations, the ratios (m) and (n) appear as either co-efficients in the case of rectangular co-ordinates or as exponents in the case of logarithmic co-ordinates.

The equations may be still further generalized by adding one more unknown (r), which must always be assumed at the start, defining the relative size of the (R) and (L) co-ordinates. In their final form they become:

$$\text{Rect. Co-ord.} \quad C = \frac{mn}{r} L + m(1 - n)\ R \qquad \text{Eq. 6}$$

$$\text{Log. Co-ord.} \quad C = L \frac{mn}{r} .\ Rm(1 - n) \qquad \text{Eq. 7}$$

$$r = \frac{\text{size of } (R) \text{ co-ordinates}}{\text{size of } (L) \text{ co-ordinates}}$$

$$n = \frac{gd}{cd}$$

$$m = \frac{\text{size of } (R) \text{ co-ordinates}}{\text{size of } (C) \text{ co-ordinates}}$$

Rectangular co-ordinates may be obtained from any decimal divided scale such as the ordinary engineer's scale, or a metric scale. The scales on the ordinary slide rule may be used for logarithmic co-ordinates giving thereby three possible variations in size; the ordinary full length (D) scale, the square or (A) scale, and the cube or (K) scale. The writer is fortunate in possessing a triangular scale on which appear the following logarithmic scales:

D20, or the (D) scale of a 20-inch slide rule
D10, or the (D) scale of a 10-inch slide rule
A10, or the (A) scale of a 10-inch slide rule
K10, or the (K) scale of a 10-inch slide rule
A5, or the (A) scale of a 5-inch slide rule
K5, or the (K) scale of a 5-inch slide rule

Thus a wide range of scales is available with considerably more ease in plotting than when using a slide rule.

Some readers will, by necessity, be using limiting values other than used herein. In case they may desire to construct similar charts, each chart will be accompanied by a full explanation as to its construction as well as application.

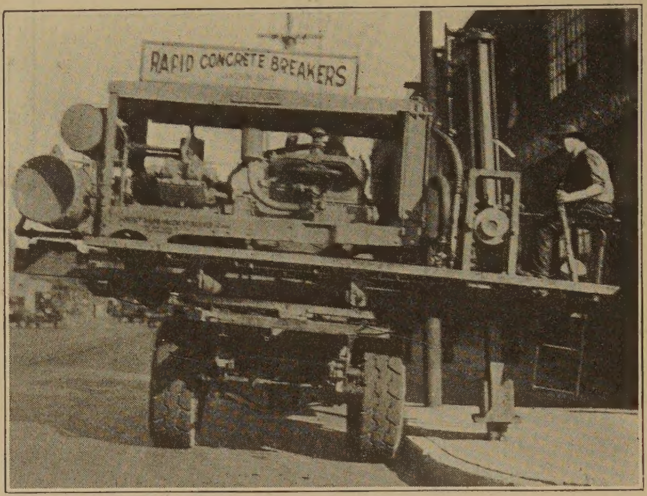
(Chart "A," with the first design problem to be solved, will be published in the April issue.)

Grade of Reinforcing

The adoption of the intermediate grade as the single standard for new billet reinforcing steel is recommended by the Department of Commerce in the publication known as Commercial Standard No. 1.

Concrete-Breaking Hammer Mounted on Turntable on Motor Truck

The hammer of the concrete-breaker shown in the accompanying photograph may be turned around to the side of the truck on which it is mounted and used in breaking up concrete sidewalks. This is accomplished by mounting the hammer and air compressor on a turntable which in turn is mounted on a motor truck in such a manner that the hammer has a horizontal swing of 10 feet, making it possible to cut a ditch 6 inches wide or 10 feet wide in one operation. Further, the cylinder head of the hammer is mounted upon a trunnion allowing it to swing backward or forward within an arc of 2½ feet so that the operator may easily gauge the size of the cut.



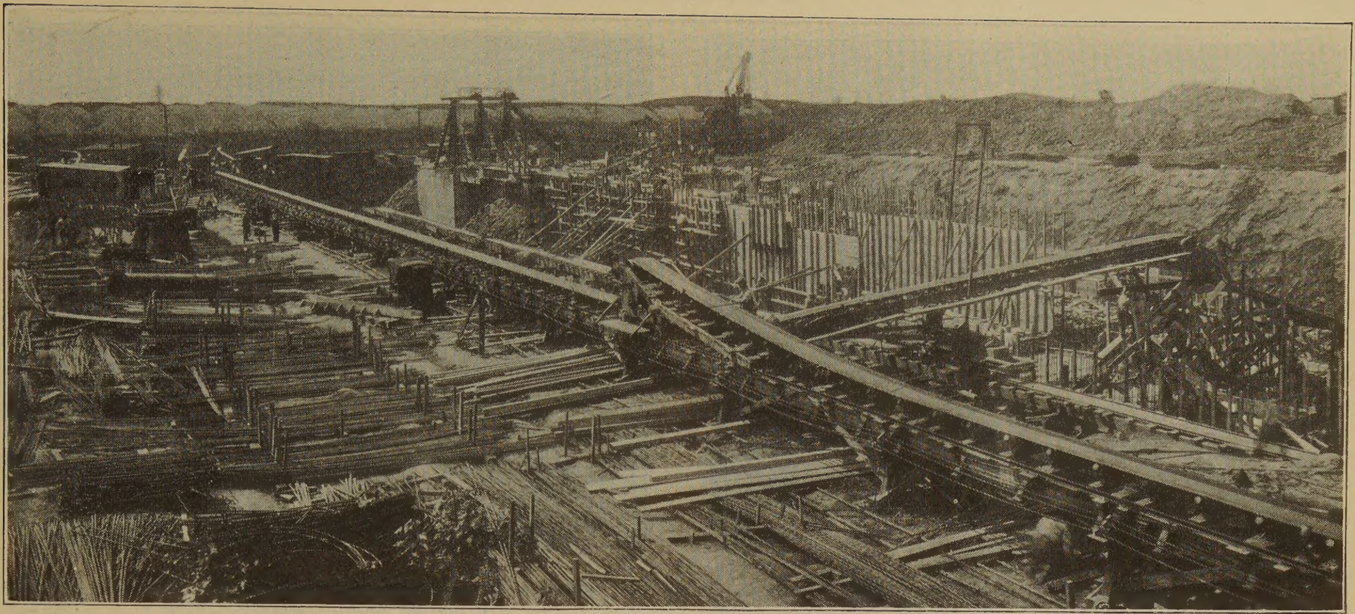
The cylinder has a stroke of 4½ feet with a striking capacity of 60 times per minute and a striking force of from 10 to 10,000 lbs. It usually requires but two or three strokes of the hammer to break up concrete pavement, depending upon the grade and thickness. This hammer has successfully broken up concrete 2 feet in thickness and has proven efficient in breaking up concrete culverts and bridge floors. It may be equipped with different types of cutters for different types of pavements. A shoe with a number of points of contact is provided in connection with the cutter for concrete. With this shoe the concrete can be crushed into small pieces so that it may be used for sub-base or may be thrown back into the ditch and used as a fill, eliminating the handling and trucking necessary when concrete is broken up in chunks and carried away.

The concrete-breaker is being used successfully in San Francisco, one of the projects being the cutting of a concrete paved street to provide a space 21 feet in width for the laying of municipal street railway tracks on Judah Street.

Standardized Forms

The division of simplified practice of the Department of Commerce is considering the nationalization of standard dimensions for removable concrete forms. This subject was introduced by the Concrete Reinforcing Steel Institute following its discussion at the last meeting of the organization.

The conference decided to standardize on the width of forms, the length and total contraction of papers, special filler widths and depths of forms.



Placing the concrete for the west side plant of the Sanitary District of Chicago. A "main line" belt conveyor delivered concrete to a portable conveyor which in turn delivered to the forms

Placing Concrete With Belt Conveyors

Belt Conveyors Have Been Found Very Practical on Many Jobs for Conveying Concrete from Mixers or Cars to the Forms—Some Conditions Favoring the Use of Belt Conveyors—How They Were Used on Several Recent Jobs—Operation Data—Precautions

TRANSPORTATION of mixed concrete by means of belt conveyors has been used successfully on a number of recent concrete construction jobs of varying character. Belt conveyors can be adapted very well to the economical and efficient handling of mixed concrete on certain types of jobs. They have a distinct advantage in that they are able to transport the dryer concrete now required on many jobs under water-cement ratio specifications. Some contractors who have used belt conveyors on quality controlled jobs have been able to make very substantial savings in cement content because the concrete could be transported and placed with a lower water content.

Range of Application

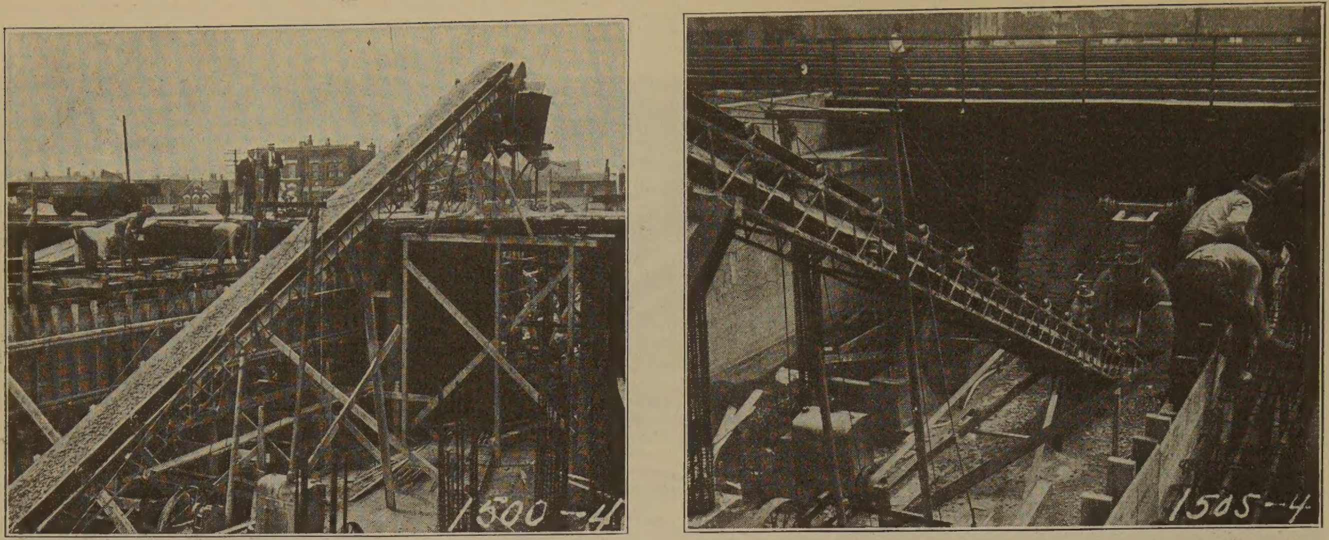
The layout of the job itself is, of course, the controlling factor as to the method of distribution to be used. Belt conveyors have been found very practical on jobs covering large areas where the concrete structure does not rise to a great height. Such jobs as sewage treatment plants, long retaining walls, sea walls, dams, tunnels, sewers and similar projects have been handled economically with belt conveyors. But their use is not limited to structures of this type. There are any number of instances where they have been used with economy in building smaller structures—bridges, foundations, subways, etc. The illustrations on these pages show some of the recent jobs on which belt conveyors were used and suggest their possible application to other jobs.

Job Arrangement

The arrangement and layout will vary depending on the job conditions. Some jobs can be handled with a single portable conveyor, carrying the concrete from the mixer to a distributing hopper over the forms as shown in several of the accompanying illustrations. On other jobs, such as sea walls, it has been found practical to erect the mixing plant on a movable platform, the mixer moving parallel to the wall while a belt conveyor, placed at right angles to the wall, carries the concrete from the mixer direct to the forms. This method has also been used successfully in building large diameter monolithic concrete sewers.

An interesting example of the use of belt conveyors on a rather large scale is found in the construction of a sewage treatment plant for the Sanitary District of Chicago. As this job covered a rather large area, a "main-line" belt conveyor, 550 feet long, was installed. This conveyor traversed the job from the central mixing plant and delivered concrete at various points either to portable conveyors placed at right angles to the "mainline" or to chutes. This arrangement provided a very flexible method for delivering concrete from a central plant to any point on the job.

Another example of the use of a belt conveyor was found in the construction of the Wanaque Dam in the northern part of Passaic County, N. J. On this job, the concrete mixing plant was located at one end of the dam near the aggregate piles and the cement shed. Concrete



How a belt conveyor was used on a subway job. The mixer was placed on the street and the concrete was delivered to a hopper over the structure for distribution in the forms

was discharged from the mixer into a hopper which fed a 20-inch belt running along the top of a temporary trestle built parallel to the new dam. Concrete was taken from the belt at any point required by means of a tripper and chuted to the forms.

Belt conveyors for handling mixed concrete are supplied in lengths of from 15 feet up to any desired length. Many are designed particularly to meet definite job conditions. Portable conveyors are, under the majority of job conditions, most satisfactory because of their mobility. They have been used in lengths up to 80 feet.

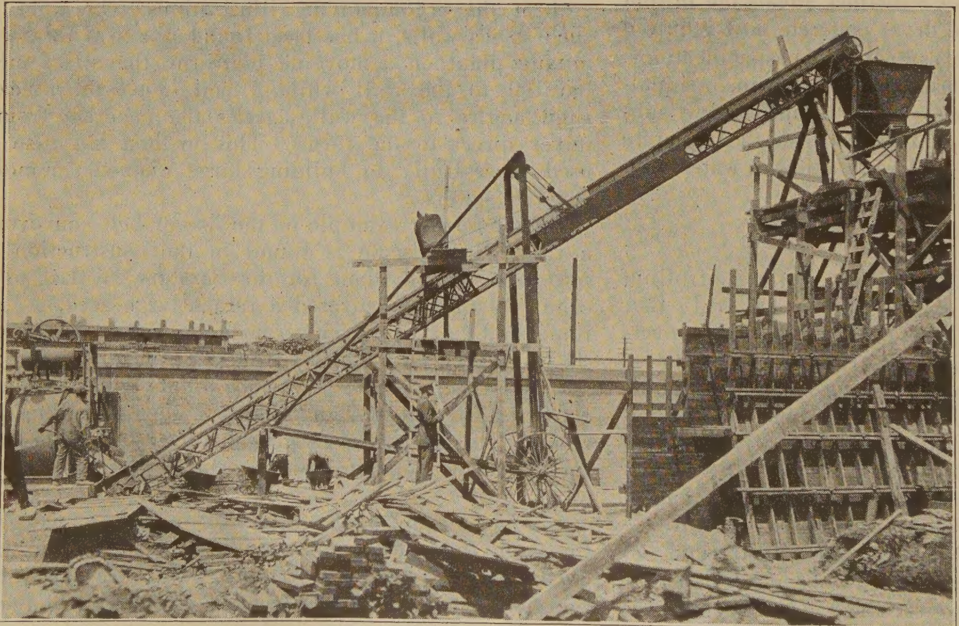
A belt to be used for this purpose should be at least 24 inches wide to get practical, satisfactory results. It has also been found that a 30-inch belt is about the maximum width practical for portable conveyors for handling mixed concrete.

Good belt material is necessary. One manufacturer recommends a covering of very nearly pure rubber. Four-ply or 5-ply belts with a 1/8-inch rubber cover have been found to render satisfactory service. Experience on a number of jobs has shown that belts of this character will run for a year or a year and a half without replacement, though one contractor reports that he has given his conveyors continuous service and has used his belts three years without replacement.

It is important that the belt be washed with a hose every time pouring of concrete is stopped. Conveyors, also, should be equipped with a scraper which automatically clears the belt of concrete. This scraper is often installed under the head pulley.

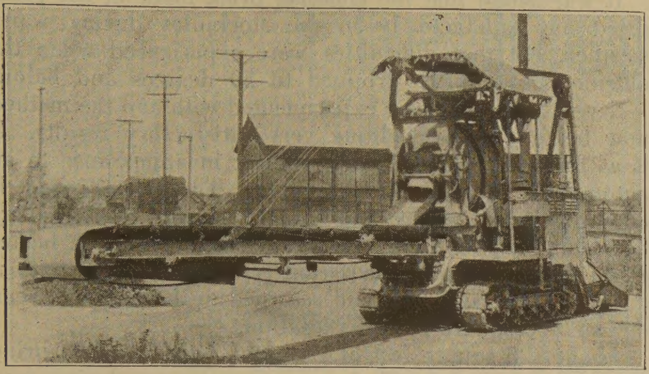
A 24-inch belt will handle approximately 40 cubic yards of concrete per hour. On one job, the average run per hour for eight hours' operation was 42 cubic yards. A 30-inch belt will, of course, handle a proportionately greater amount of concrete.

Belt conveyors operate at speeds of from 250 to 300 feet per minute. The power required to operate the belts for conveying concrete is about three times greater than for loose materials. One conveyor uses a 20-h.p. engine for a 24-inch belt 60 feet long. Another uses a 15-h.p.

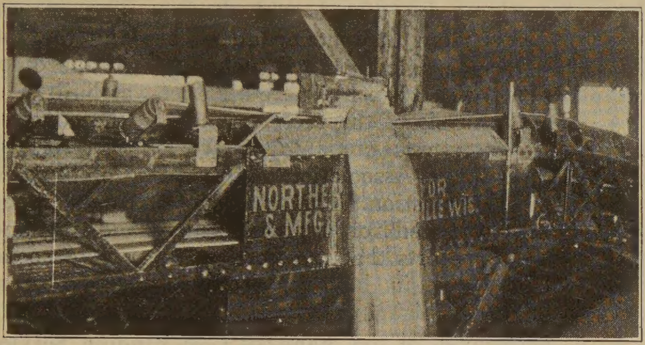


An efficient layout in which a portable belt conveyor was used for building retaining walls engine for the same size and capacity conveyor, the engine operating through a 2 to 1 gear reduction.

It has been found in practice that it is not practicable to use belt conveyors on jobs where concrete must be elevated to a height of more than 30 feet above the mixer. Dry concrete will travel up a belt conveyor satisfactorily at an angle of 25 or 30 degrees while a 20-degree slope is the maximum for wet concrete.



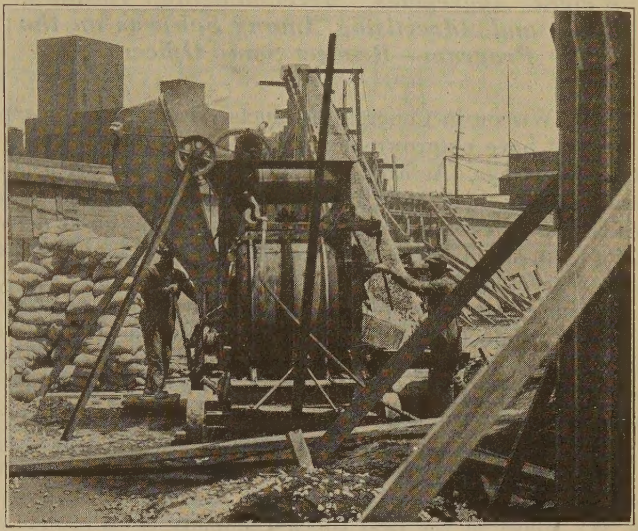
A belt conveyor attached directly to a paving mixer



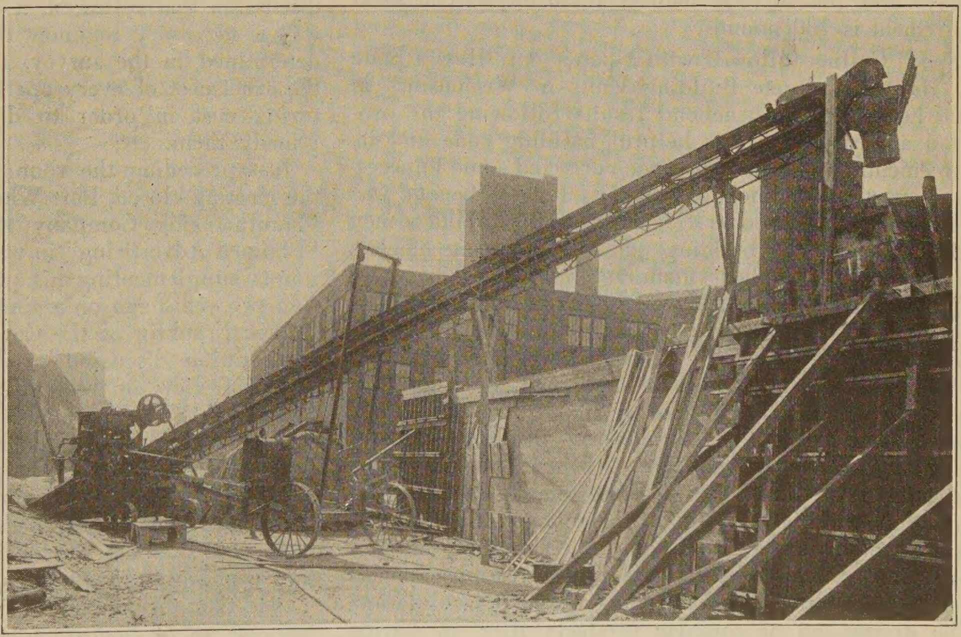
A scraper attached to a belt conveyor for transporting concrete

Writing on the subject of distributing concrete by belt conveyors in the Proceedings of the American Society for Testing Materials, Nelson L. Doe says: "For well-mixed concrete having a slump of not over 5 inches practically no segregation takes place on belts even on considerable inclines. Concrete of a sloppy consistency cannot be handled by inclined belts without marked segregation, as the fine materials tend to flow down the center of the incline, leaving the larger aggregates on the edge of the belt.

"Proper loading and unloading arrangements for belt conveyors are important. Concrete conveyed by belts should be discharged into a receiving hopper of ample capacity, so that the concrete from the belt falls directly into a mass of concrete and does not strike a sloping surface. Belt conveyors should be charged from a hopper through a bottom gate and not fed directly from the mixer chute. In this way the discharge can be gauged so that a continuous stream of concrete can be maintained on the belt with a single mixer, giving uniform conditions of distribution."



Showing how the mixer discharges onto the belt. Some engineers recommend that concrete should be discharged from the mixer into a hopper and then from the hopper onto the belt



A subway abutment job, the concrete for which was handled by belt conveyor

Cost, Production and Selling Problems Considered at Wisconsin Products Meeting

Products Manufacturers in Helpful Discussions During Sixth Annual Meeting of the Wisconsin Concrete Products Association—Many Out-of-State Guests Attend — Costs, Curing, Light-Weight Aggregates, Merchandising, Building Codes and Advertising Among Subjects on the Program—Re-elect Same Officers

THE Wisconsin Concrete Products Association conventions have outgrown the restrictions of being merely state gatherings. At least this held true for the sixth annual meeting, held in Milwaukee, February 2nd and 3rd, which was in effect a regional meeting, having guest delegates from six midwestern states. More than 250 delegates were registered.

A wide range of problems, all of vital interest to every concrete products manufacturer, came up for discussion during the convention. Much stress was put on operating problems and a feature of the program was a series of ten-minute papers, grouped under the general subject of "Operating Problems in Concrete Products Manufacture."

The first of the papers presented under this symposium was on the subject of light-weight aggregates, read by A. W. Scheer of the Best Block Company of Milwaukee, in which the experiences of this company with Haydite were reviewed. Haydite, weighing from 1400 to 1700 pounds per cubic yard, will produce concrete that will be from 30 to 35 per cent lighter than concrete in which other aggregates are used. The mix used by the Best company is about 2/3 of coarse Haydite and 1/3 fine. About 35 gallons of water are used for each cubic yard of aggregate, though the water content must be changed frequently to compensate for varying conditions in the aggregate. A 42 cubic foot mixer is used. The Haydite is mixed dry with the cement for 4 or 5 minutes. Then water is added and the mixing is continued for another 5 minutes. This procedure has been found to yield the best results. Lots of tamping is required and the concrete sets very fast.

Tests made with Haydite block yielding 30 blocks per sack of cement showed strengths of 660 to 980 pounds at 15 days and 780 to 1450 pounds at 30 days. The local requirement is 700 pounds.

"Spec" Collins followed with a paper on, "How a State Law Helped Concrete Building Units in Wisconsin," in which he traced the beneficial results following the promotion and adoption of a helpful building code and its enforcement. While the new code corrected some unnecessary restrictions in the old code, its biggest benefit was the resulting close co-operation between the products men in the state and the building officials. Building officials learned that the products manufacturers were sincere in their desire to maintain a high standard of quality in their products and they knew that they could work with the products manufacturers for the welfare of the industry.

"Mergers" was the subject of another of the ten-minute papers, in which Wm. Rathke of Eau Claire traced the trend toward mergers in the concrete products industry and cited reasons why they are of benefit. He suggested consolidation of plants as a possible remedy for the overproduction and the resulting price competition now so common among block manufacturers. The many obvious savings in overhead, delivery and administration expenses were, he considered, arguments in favor of consolidation.

The drying out of concrete products after the curing process and before they are delivered to the job, was the subject of a paper by L. E. Grube, president of the association. His paper described the experiments made at his plant in Sheboygan.

It was found that the concrete brick made at the plant dried out satisfactorily in the stockpiles during warm weather, but that difficulties were experienced when the outside temperatures dropped to 50 degrees and below.

Several methods were experimented with and the method now being used is yielding very satisfactory results. It is as follows: A unit-heater, similar in appearance to an automobile radiator, was secured. The heater used is about 30 inches square and about 10 inches thick, having horizontal copper tubes. Steam is admitted to the heater at the top and the condensation is drained at the bottom through a Dunham trap and returned to the boiler. It can deliver 500 square feet of radiation.

About 125 square feet of radiation is required to bring the drying tunnel to 75 degrees temperature during zero weather. This takes into account the evaporation taking place when the brick give up their moisture.

The heater is mounted on a portable chassis. Directly behind it, on the same chassis, is a fan. The heater and fan are placed as near the floor as possible and the heat is driven into the drying tunnels with the fan. The air supply was taken from the outside and forced by the fan through a 12-inch hole in the tunnel door. At the other end of the tunnel a 16-inch square air duct was built.

A careful analysis of the present trends in the concrete products industry was prepared by W. D. M. Allan of the Portland Cement Association and read by Bob Smythe, also of that organization. The paper pointed out, among other things, the need for aggressive merchandising and suggested some efforts that the Portland Cement Association was planning in helping products manufacturers with their merchandising problems.

E. E. Sheasgreen of the Standard Cost Finding Service Company of Minneapolis, conducted a cost finding survey during the course of the convention in which the costs in a hypothetical plant having two power machines were analyzed. With an actual production of 600,000 block per year, it was found that the total manufacturing and sales costs should be a little less than 14 cents per block. The object of the survey was to point out the need of keeping accurate records and to figure into the cost every item that directly or indirectly affected it. During the discussion that followed, it was emphasized that not only was it necessary to know the total cost of the block as determined in the survey, but it was necessary to know the exact cost of every operation going into the manufacturing cost in order to discover the weak points and remedy them.

Just preceding the round table discussion with which the meeting closed, Bert Wheeler of the Marquette Cement Manufacturing Company read an instructive paper on "Planned Advertising" in which he brought out additional points supplementing his paper before the same convention two years ago on a similar subject.

Jack Franklin of the Consolidated Concrete Machinery Corporation discussed products plant layouts from the point of view of reducing manufacturing costs. L. S. Grube was re-elected as president of the association, A. W. Scheer, vice-president, and E. B. Bushnell, secretary. It is no little task to get a group of men to work together in harmony as the Wisconsin products manufacturers are doing and it is largely because of the untiring efforts of these men that the Wisconsin Concrete Products Association has grown in numbers and usefulness.

And then, of course, there was the banquet! Little need be said about that to anyone who has ever attended a banquet of the Wisconsin Concrete Products Association.

Bookkeeping—The Key to Profit in Products Plants

The Second Article in This Series Showing How Accurate Bookkeeping Increases Profits—Part II Continues the Discussion of Manufacturing Costs Begun in the February Issue—Pay Roll Forms, Pay Roll Distribution, Direct Labor Costs and Material Costs Are Considered in This Chapter

By **WILLARD R. GINDER, C. P. A.**
Formerly Assistant Treasurer, National Building Units Corporation

Part II.—Manufacturing Cost (Continued)

LABOR, in a manufacturing plant, is divided into two classes for accounting purposes: direct or productive labor and indirect or non-productive labor. Direct labor is that which is expended directly on the product in the process of manufacture. All other labor in the plant is included in indirect labor, which is part of the overhead expense.

Direct Labor Operations

Direct labor operations, in the average block plant, consist of the following:

1. Conveying aggregate from plant storage to aggregate hopper or elevator.
2. Operating aggregate preparation and elevating machinery. (Not including repair work.)
3. Conveying cement from plant storage to mixer.
4. Filling and operating mixer.
5. Conveying prepared material from mixer to molding machines, or operating machinery which performs this function.
6. Operating molding machines, including feeding and racking.
7. Conveying molded blocks from racks to steam kilns and to permanent storage piles.

Operations 1 and 2; 4 and possibly 5; and 5 and 6 may be grouped so that direct labor will consist of but four major operations:

A—1 and 2;
B—3, 4 and possibly 5 or part of 5;
C—5 and 6;
D—7.

Each pay roll should be analyzed to show the amount chargeable to each of operations A and B, and the amount chargeable to each style and size unit processed for each of operations C and D. These data, along with somewhat similar data on indirect labor, are accumulated for the month on the pay roll distribution sheet, the detailed preparation of which is discussed below.

Direct Labor Per Unit—Operations A and B

The direct labor cost of operations A and B may consist partly or entirely of piece-work labor, or partly or entirely of time-work labor. Piece-work labor cost per unit, of any style or size, consists of the sum of the piece-work rates for work composing the operation.

The problem then before us is to determine the cost of time labor per unit.

Operations A and B have to do only with preparation of materials, and it is therefore deemed sound to assume that time labor per unit will vary in proportion to the amount of material in the unit. Determination of labor cost per unit on this basis is easily accomplished, by either the material cost or the dry-weight method.

Material Cost Method

Average time labor per month, for any operation included in A and B, divided by average cost of material used per month will give time labor per cent's worth of material used. Time labor per unit of any style and size will then equal cost of material used per unit of that style and size, multiplied by time labor per cent's worth of material used.

T equals Average Total Time Labor per Month on Operations A and B.

M equals Average Total Cost of Material Used per Month.

Tm equals Time Labor per Cent's Worth of Material Used.

T divided by M equals Tm.

Ms equals Cost of Material Used per Unit of Any Given Style and Size.

Ms multiplied by Tm equals Time Labor per Unit.

Dry-Weight Method

The dry-weight method will probably give identical results, and inasmuch as dry-weight data is valuable for other purposes, that method is recommended. The procedure is as follows:

Average total dry-weight produced per month is ascertained as described in the preceding article, under the subject of material. Time labor per pound of dry-weight produced is then obtained, by dividing average total time

PAY ROLL ANALYSIS. *Figure 5*

Week Ended ______________, 192____.

Cement Cartage	Cement Handling	Cartage	Handling	Cartage	Handling	Cartage	Handling	DIRECT LABOR				Hauling Blocks	Hauling Mat. Sold	Loading Blocks	Loading Mat. Sold
								Oper. A	Oper. B	Oper. C	Oper. D				

Power, Heat & Light	General Plant Exp.	General Yard Exp.	Repairs Buildings	REPAIRS—MACHINERY AND EQUIPMENT				Repairs Yard	Pallet Clean., Oil.	Super-vision	Watch-men	Sundry Indirect Labor	Office	Salesmen	Collection Expense
				Oper. A	Oper. B	Oper. C	Oper. D								

MANAGEMENT															
Mfg.	Selling	Admin.													

Actual size of sheet 17 by 14 inches, containing three tiers of columns

labor cost per month by average total dry-weight produced. Time labor per unit of any given style and size is then found by multiplying time labor per pound of dry-weight produced by dry-weight per unit of the size and style under consideration.

W equals Average Total Dry-Weight Produced per Month.

T equals Average Total Time Labor per Month on Operations A and B.

Tw equals Time Labor per Pound of Dry-Weight Produced.

Tw equals T divided by W.

Ts equals Time Labor per Unit of Any Given Style and Size.

Ws equals Dry-Weight per Unit of Same Style and Size.

Ts equals Tw multiplied by Ws.

Material preparation direct labor cost per unit (operations A and B) consists of the piece-work labor cost plus the time labor cost.

It might be of interest to compare piece-work rates with the results obtained by allocating the average total cost of piece-work labor per month to specific styles and sizes, by one of the above methods. The results of such tests might indicate the advisability of readjusting piece-work rates, or might uncover errors in piece-work wages paid.

Direct Labor Per Unit—Operations C and D

Direct labor on operations C and D is often on a piece-work basis, but even if it is not, its allocation is comparatively simple.

If the pay roll analysis and distribution suggested above is maintained, the direct labor cost per unit is easily obtained as follows:

Total labor on operation C for any given style and size, for the month, divided by the number of such units *produced* during that month will give labor cost per unit. Total labor on operation D for any given style and size, for the month, divided by the number of such units *yarded* during that month, will give labor cost per unit.

It might be interesting to make the above computations, and compare the results with piece-work rates, where such are in use, as a pay roll and cost test.

Total Direct Labor Cost

Direct labor cost per unit has now been computed, and it will be readily seen that the computation has been based upon data supplied by the books, or by records controlled by the books. Even if piece-work rates are used for computing direct labor cost, the tests suggested above will have the effect of authenticating the figures used.

Direct labor cost computations may be summarized as follows:

For any style and size unit:

Operations included in A and B	Piece-work rates plus Time labor in proportion to material content or cost.
Operations included in C and D	Piece-work rates plus Time labor divided by number of units produced, or yarded.

Pay Roll Accounting and Distribution

Pay Roll Suspense Account

The pay roll analysis and distribution forms, presented in Figures 5 and 6, respectively, have been designed for use in conjunction with a Pay Roll Suspense Account. This account is debited for all cash disbursements for wages or salaries, and receives one credit each month from the Pay Roll Distribution.

Figure 6

STANDARD CONCRETE PRODUCTS COMPANY

PAY ROLL DISTRIBUTION

Month of ...., 192.....

ACCOUNTS	Accrued 1st of Mo.	First Week	Second Week	Third Week	Fourth Week	Accrued End of Mo.	Net Totals
Cement Cartage							
Cement Handling							
.... Cartage							
.... Handling							
.... Cartage							
.... Handling							
.... Cartage							
.... Handling							
Direct Labor—Oper. A							
Direct Labor—Oper. B							
Direct Labor—Oper. C.—P. W.							
Direct Labor—Oper. C—Time							
Direct Labor—Oper. D—P. W.							
Direct Labor—Oper. D—Time							
Hauling Blocks							
Hauling Materials Sold							
Loading Blocks							
Loading Materials Sold							
Heating Plant							
General Plant Expense							
General Yard Expense							
Repairs—Buildings							
Repairs—Mach. & Equip.—Oper. A							
Repairs—Mach. & Equip.—Oper. B							
Repairs—Mach. & Equip.—Oper. C							
Repairs—Mach. & Equip.—Oper. D							
Repairs—Yard							
Repairs—Motor Trucks							
Pallet Cleaning & Oiling							
Supervision							
Watchmen							
Sundry Indirect Labor							
Total Plant Pay Rolls							
Office Salaries							
Management Salary—Mfg.							
Management Salary—Selling							
Management Salary—Admin.							
Salesmen							
Collection Expense							
Total Office Pay Rolls							
Total Pay Rolls							

Actual size of sheet is 11 by 14 inches. Fig. 7 is on reverse side

Figure 7

STANDARD CONCRETE PRODUCTS COMPANY

ANALYSIS OF DIRECT LABOR—OPERATIONS C & D—BY STYLE & SIZE

Month of ...., 192.....

Styles and Sizes	Accrued 1st of Mo.	First Week	Second Week	Third Week	Fourth Week	Accrued End of Mo.	Net Totals
OPERATION C							
OPERATION D							

Fig. 7 is the back of Fig. 6 and contains lines sufficient for 22 sizes under each operation—C and D

Pay Roll Analysis Sheet

Time, for each day on cards or other records, is converted into amounts due for wages, and these amounts are posted to the appropriate columns of the Pay Roll Analysis. A column is provided on this sheet for each account to which labor is to be charged, several columns having been left blank for accounts for which charges may arise from time to time. Sufficient columns are also provided for analysis of Operations C and D Direct Labor, by styles and sizes manufactured or yarded.

At the end of each week, the Pay Roll Analysis is totaled, and its grand total is compared and should equal the amount of the pay roll for that week. Totals of all columns on the Pay Roll Analysis are then posted to the proper lines of the Pay Roll Distribution, in the column corresponding to the week just ended, and totals of columns containing analysis of Operations C and D Direct Labor are similarly posted to the other side of the pay roll distribution sheet, which is illustrated in Figure 7.

The Pay Roll Analysis has then served its purpose, except as it may be needed for reference, and is filed.

At the end of each month, the analysis sheet containing the last few days of the month is totaled and posted to the "Accrued End of Month" column of the distribution sheet. This analysis sheet is then continued in use until the end of the week, and its final totals are posted to the "First Week" column of the distribution sheet for the next month.

After posting each analysis sheet to the distribution sheet, that column of the distribution sheet is totaled, and its total is compared with and should equal the amount of the pay roll for that week.

At the end of the month, the distribution sheet is totaled across to obtain the total debit to each account for the month. In totaling this sheet across, the amount in "Accrued—1st of Month" column is subtracted from the sum of the amounts in the other columns. The amounts in the "Net Total" column are then posted as debits to the accounts indicated, and the total of this column is posted to the credit of Pay Roll Suspense.

Pay Roll Suspense should contain a credit balance equal to the total of the "Accrued—End of Month" column of the distribution sheet, at the end of the month after all general ledger postings have been made. This balance represents the liability existing for accrued wages and salaries at the end of the month.

All amounts in the "Accrued—End of Month" column of a distribution sheet are entered in red, in the "Accrued —1st of Month" column of the distribution sheet for the succeeding month.

As noted above, the other side of the distribution sheet provides for accumulating total Operations C and D Direct Labor on each style and size for the month. It is suggested that a card be kept for each size and style unit, upon which the quantities produced and yarded, and the amounts of Operations C and D Direct Labor, for each month, are to be entered.

(To Be Continued)

New French Method of Building Concrete Dam

An exceedingly novel method of construction is to be employed for a new dam which is to be built at Marege, in the Haute-Dordogne, France. The ordinary form of dam consisting of a single wall, either straight or curved, which by its mass and thickness is enabled to hold up a certain weight of water will be replaced by a series of walls, each comparatively thin. Moreover, some of the water itself can be made to act as a counterweight and the quantity of masonry required can be still further reduced.

Five thin curved shells of reinforced concrete are to be placed one behind the other. Each will be somewhat lower than the preceding one, so that the desired head of water will be obtained in five stages instead of in a single step. When the system is filled with water, the water in each compartment will rise to the top of the lower wall and will help to support the higher wall up to that height. Only one-fifth of each wall, and that at the top of it, where there is least pressure, will be subjected to pressure acting in one direction only. The first four walls will not require to be thickened at their bases, and an economy of over 25 per cent will be effected.

Tests have been made on a scale model in the following way: The density of mercury is 13.6 times that of water. Consequently, if a model of the dam is made of the same materials as the dam itself but on a scale of 1 to 13.6, and filled with mercury, the resulting pressures are equivalent to those which would be obtained in practice. The scale, however, is still impossibly large, but this difficulty can be overcome by altering the material. A certain kind of plaster is consistently 7.35 times less resistant than concrete. When this plaster is utilized instead of concrete, and mercury is used instead of water, a multiplication of forces of 7.35 times 13.6 is obtained, or 99.96. A model on a scale of 1 to 100 made of this material will, therefore, give all the results necessary.

Pueblo Ruins 200 Years Old Reinforced with Concrete

The ruins of the Pecos church at the old pueblo ruins of the same name 35 miles southeast of Santa Fe, New Mexico, have been given an extension of life by the building around the base of the adobe ruins a reinforcement of concrete.

The church was built in 1617 of baked mud or adobe blocks with walls from six to eight feet thick and with a height of more than 60 feet. It connects the early Spanish settlements of the Southwest, the Pueblo Indians of that region and the history of America so closely together that means of preserving the ruins as long as possible were undertaken.

Concrete reinforcements around the base of the adobe walls to a height of from four to six feet, both inside as well as outside have been finished. This work has been colored to imitate the adobe construction. It was impossible to construct the work without leaving it conspicuous and yet not destroy more of the old walls. It is expected that the continuous crumbling of the upper parts of the walls will gradually cover the cement work, hiding it from view, so as to present the original construction.

EDITORIALS

Products Plant Management

IN the concrete products industry, as in many other industries, one of the greatest present needs is better business management. Too often the products manufacturer "carries his office around under his hat" and all the records of the business are there—and no other place! It is not so hard to see, under such conditions, why records of important transactions are often lost or misunderstood. Unfortunately man is a mortal being and his memory is seldom perfect.

Accurate business records are not so difficult to understand and they actually consume very little time. Some products manufacturers have started methods of keeping records and have been surprised to find that half an hour a day will keep all records in shipshape order. Of course, when the volume of business warrants it, it is well to have someone in the office who makes this his job along with other work.

It is impossible to overestimate the benefits that follow the keeping of business and cost records. To know what your blocks are costing is to be able to arrive at a fair sales price. There would be less indiscriminate price cutting if every products manufacturer knew what his block cost in the yard. Records such as this point out means of reducing costs, also.

Your customers, too, the men with whom you do business, are quick to notice how you handle your affairs. And it makes a big difference in their estimation of you and your product. Some manufacturers have built up their reputations on the neatness and accuracy of, for instance, the invoices they send to their buyers.

These are not theoretical imaginings. Business principles are necessary in this age of keen competition. Experience has proved it. Ask any really successful products manufacturer.

Because there are still many concrete products manufacturers who do not have a simple, practical method of keeping their records, "Concrete" is presenting from month to month, articles that will help the products man to select a method or that will enable him to improve the method he now uses. It is worth while to take the time to read these articles and to study them in relation to your business problems.

A Healthy Tendency

TALKING to a salesman for a contractors' equipment house the other day, we ran onto a bit of very concrete evidence of the way in which concrete contractors are beginning to take a better view of their business problems.

This salesman told us that a few years ago the job of selling concrete mixers was a relatively simple one. All you had to do was locate a contractor who needed a mixer, and quote him a price that was right. And even when the price wasn't the lowest one, personal friendship would sometimes make up the difference. But today things are different. This salesman now finds it necessary to see not only the contractor, but his construction superintendent, maybe the foreman, and then back to the purchasing agent or contractor again. And then after all this explaining to various people, the sale is sometimes lost because the superintendent is found to prefer the water tank, or the engine, or the bearings, or some other detail of a different mixer. And somehow all through the whole transaction there is never an adequate opportunity to explain the low price that can be made on the mixer.

According to this machinery salesman, the trouble all started with the water-cement ratio. Many contractors did not understand this new theory, the salesman told us, but their engineers and superintendents did. And once they had started to look at the water measuring devices that various mixers had to offer, they went on to look at other construction details, with the result that they soon became a pretty critical bunch of mixer buyers. Contractors who felt that they had a right to hold their superintendents responsible for the quality and cost of the concrete on their jobs, also felt that it was only fair to buy machinery as much on performance as on price. And the result is that machinery salesmen now have to do a good deal more leg work than in the good old days.

This condition of affairs is a mighty healthy symptom, and it looks like another step in the right direction which the industry is going to have to credit, at least in part, to the water-cement ratio.

Skyscraper Factories

New Industrial Development of Concrete Flat Slab Factory Skyscrapers Follows Opening of Holland Tunnels—More Than 2,000,000 Square Feet of Heavy Floor Construction—Rented Like Office Buildings—Factory Uses Introduce Interesting Design Problems—Structural Steel Column Cores Used

By **W. W. HAY**

THE opening of the Holland vehicular tunnels between New York City and New Jersey witnessed the culmination of an industrial development without parallel in the history of real estate, a development involving the construction of more than two million square feet of heavy floor construction on a street scarcely ten blocks long. The actual inception was due to a combination of circumstances, but the results have been so successful that others elsewhere have taken advantage of the lessons learned here and many buildings of a similar character are being erected in large numbers.

Almost three years before the scheduled opening of the Holland tunnels to traffic, it became apparent to realtors that unless satisfactory space at competing rents could be provided, there would be a large exodus to New Jersey of certain classes of heavy manufacturing and distribution. It was a question of combining low ground values in a good location with first class industrial construction, and as such a district was not in existence, it became necessary to create it.

The Trinity Corporation owned many large plots of ground on or nearby Varick Street, a wide thoroughfare forming the principal northbound street from the tunnels, and this ground has been leased at nominal values. Many individuals and corporations have erected the buildings with the financial help of Trinity; and the space has been largely leased by the real estate brokers who originated the development.

Concrete Flat Slab Construction Used

Without exception, the buildings are of reinforced concrete flat slab construction, designed for live loads of 200 lbs. or 250 lbs. per sq. ft., fully sprinklered, with high ceilings, and such other facilities as go to make the floors as fine manufacturing space as can be built in congested areas. The structures are all either eight, ten or twelve stories in height, having from 13,000 sq. ft. to 35,000 sq. ft. on a floor. There are many other interesting features about these buildings, among which may be mentioned the use of structural steel column cores, and the handling of the set-backs. The influence of some of the features of this group has been so marked in real estate development that they have given a name to such property,—"Varick Street loft type."

The average city loft building is designed for "light manufacturing," for live loads of 120 or 150 lbs. per sq. ft., and the floor heights are seldom more than 10 ft., the window openings are relatively small, and they would not elsewhere be considered good industrial space. The industries to be provided for here included printers and allied trades and businesses, requiring a heavy floor construction, and better light. Reinforced concrete flat slab construction was adopted, as it is economical for heavy live loads and through its larger inertia absorbs vibrations, the lighting is superior for low story heights, and lines of shafting can be placed where desired. Actually a story height of 13 ft. is almost universal, resulting in natural light sufficient for machine tools over about 65 per cent of the gross floor space. In general, the columns are spaced from 18 to 20 ft. and since the enlargement of the columns in the lower floors would have been objectionable, structural steel cores have been used to maintain a minimum column diameter.

A construction view of standard industrial construction

Column Design

In the design of the interior columns, the minimum diameter was determined by the point at which it would become cheaper to substitute structural steel for the spiral column shaft, or usually seven floors below the roof slab for loads of 200 lbs., and six floors below for 250 lbs., live load. The building code of New York City requires all the load on such a column to be carried by the structural steel, but permits the use of 16,000 lbs. per sq. in.

on this core, plus an additional 0.5 per cent of reinforcing. This results in a 12-in. H core, or a 14-in. H, and since the code requires a minimum covering of 4 in. of concrete, the shaft diameters are 26 in. or 32 in., and the additional reinforcing required will work out to ½-in. ø bands spaced 6 in., and four ⅞-in. ø vertical rods. The reduction of live load permitted by the code is such that the increments of load from floor to floor are so small that the section area can be increased by adding and increasing 8-in. plates to both sides of the web of the H-column, as indicated in Fig. 1.

The method of passing from the structural steel to the reinforced concrete spiral column is indicated by Fig. 2. The load on the footing is transmitted by a heavy steel billet. The load coming to the structural steel column at each floor is sometimes transmitted by standard beam seat-brackets, the plane of the seat being that of the column drop panel.

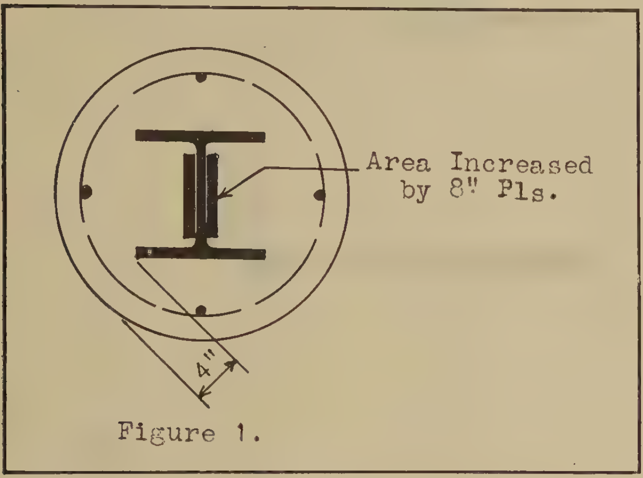


Figure 1.

Set-Backs

The handling of the set-backs required by the zoning regulations is simple enough in beam-and-girder structures, but until recently was very rare in flat slab construction. A great deal of credit in the development of set-backs with flat slab construction is due the architect of the Master Printers' Building, Frank S. Parker, of New York. This is an eighteen-story structure, with roof penthouse and basement, having set-backs on three sides, and is the highest reinforced concrete structure yet erected, the roof slab being 274 ft. above the street. It is designed for 250 lbs. live load, and with its 560,000 sq. ft. of space

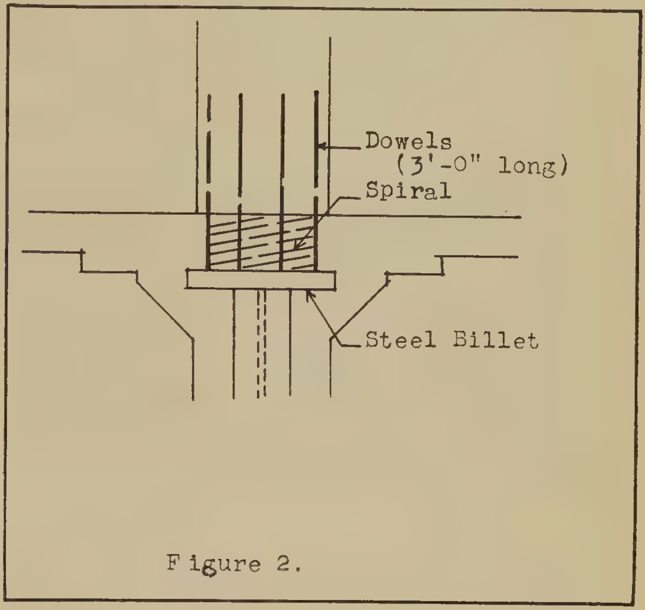
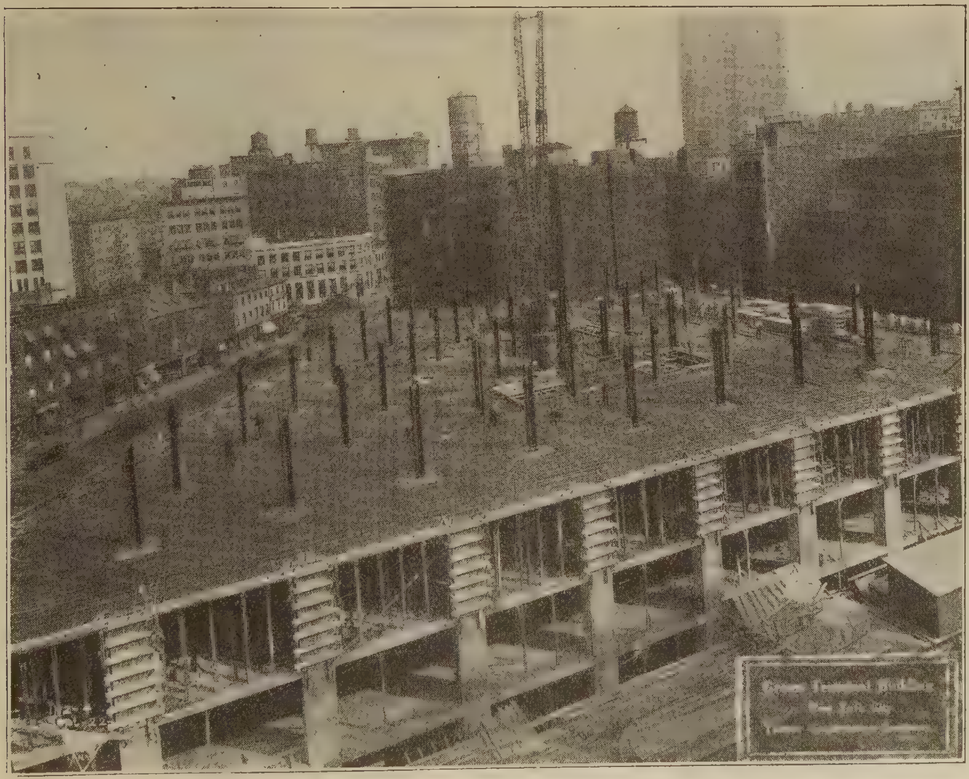


Figure 2.



The structural steel cores and flat slab floors in the construction of the Green Terminal Building is probably the largest building of its capacity and use in existence. This building was described in the February issue of CONCRETE.

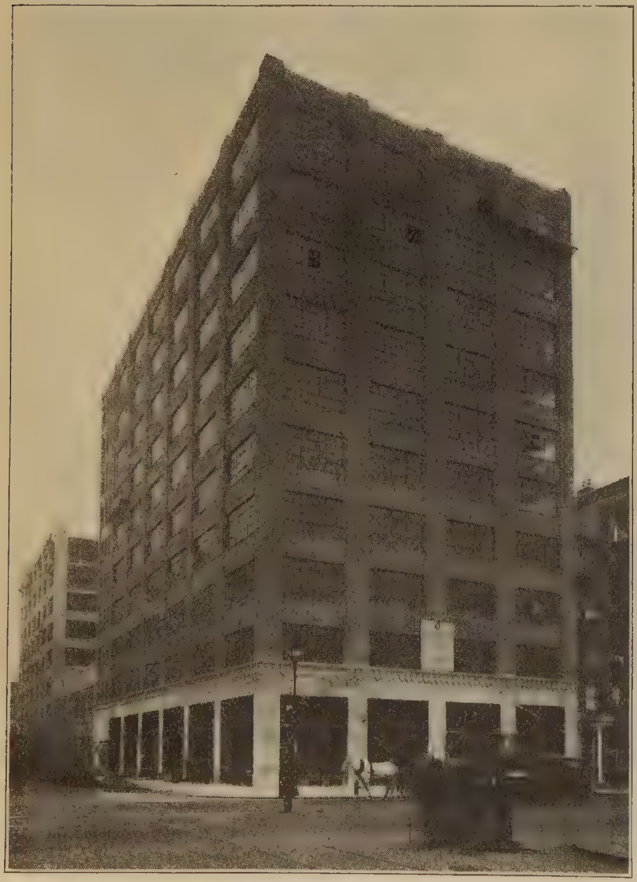
Following the success of the Varick Street lofts and the successful use of the set-back with this type of construction, the use of flat slab construction for lofts having heavy floor loads has spread very rapidly, and at the present writing there are four under construction in a small area of three blocks, including one of 17 stories, one of 14 stories, and two 12 stories high, with others, including one of 18 floors, projected.

A conventional cross-section showing the manner in which set-backs have been handled is shown by Fig. 3. In certain zones, a rear set-back of 2 in. in 12 in., or 4 ft. in two stories of 12 ft., is required, and one such set-back can be made without additional framing, as the load comes within the point of counter-flexure and in effect balances the interior floor load. On the street elevations the set-back is more marked and beams have to be introduced. The set-back on the street seldom starts below the eighth floor level and on very wide streets may not occur until the 13th floor level is reached. In the case of the Varick Street lofts, no set-back was necessary on Varick Street, but in some cases it was required on the side streets.

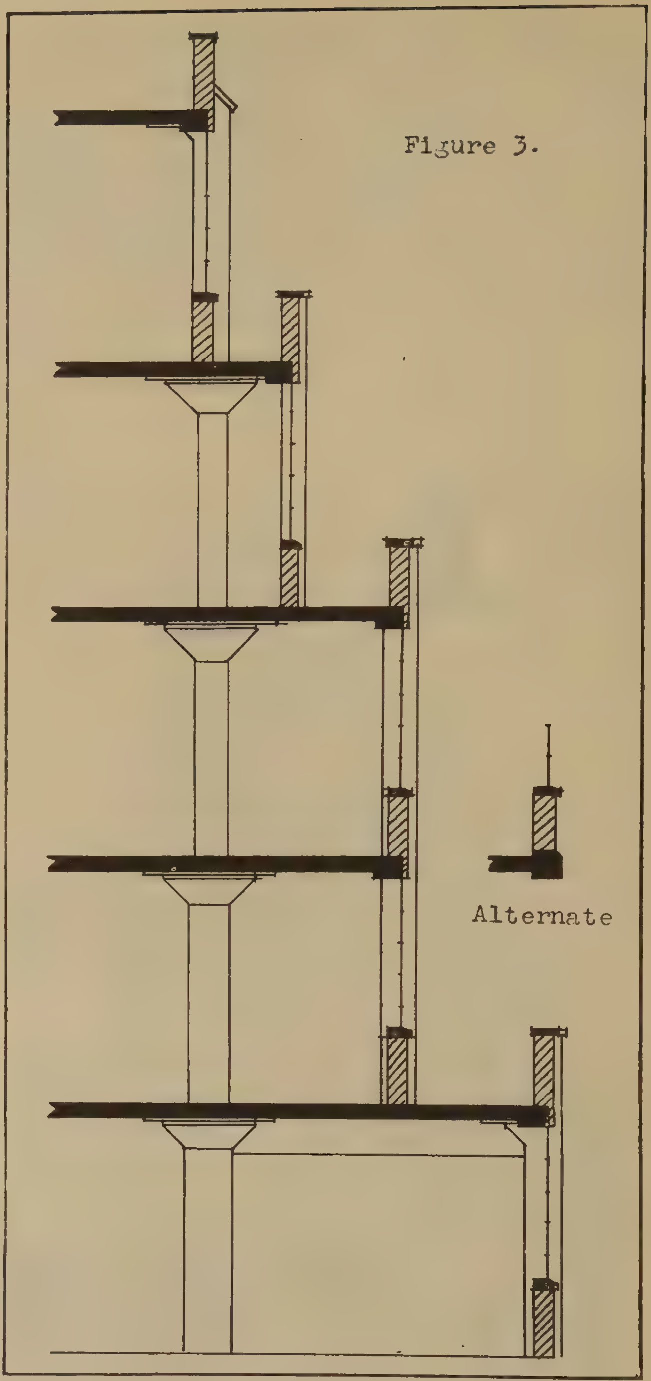
Costs

The cost of these buildings has been about 45 cents per cubic foot. Where the land values are low, as in the case of the Trinity leaseholds, space has been rented for 80 to 85 cents per sq. ft. for entire floors. This compares with rents of over $1 per sq. ft. for equal space in districts of high land values.

The location, low rents, heavy construction, and general excellence of these buildings have attracted many tenants of a national character and in varied industries, both for manufacturing and distribution purposes. Other localities and other cities are following, because the Varick Street development has proved that there is a demand for such industrial space and financial agents are now prepared to assist the construction elsewhere.



A completed skyscraper factory



Coming Conventions

March 1st, 2nd, 3rd—National Cinder Concrete Products Association, at the Benjamin Franklin Hotel, Philadelphia, Pa. Fifth annual convention.

March 19th to 21st—Concrete Reinforcing Steel Institute, at Edgewater Gulf Hotel, Biloxi, Mississippi. Fourth annual meeting.

Test Light-Weight Aggregate Block and Concrete Floor Slab in Fire

Erect House with Basement for Fire Test—Haydite Concrete Block Withstand 1480 Deg. Heat—Reinforced Concrete Floor Stands Up Well

MASONRY units of light-weight aggregate were given a severe test in a Fire Prevention Week demonstration at Indianapolis, Indiana, that was of more than local interest. Haydite concrete block formed the walls of a basement-and-one-story experimental house having a concrete floor slab and designed to illustrate the fireproof qualities of concrete floors.

This test house consisted of a living room, furnished with furniture and cut flowers, and the basement. The basement was constructed above the ground. On a dry tamped flooring, five courses of 8- by 8- by 16-inch block were laid, forming a 3½-ft. basement. On this was placed a 6-inch reinforced concrete slab, at the time of test but 7 days old. The slab was given a 4-inch bearing on the wall and 8- by 4- by 16-inch block were used to finish out the course. This was offset about 1 inch to allow clearance between the block and the slab, producing the effect of a belt course around the entire house at the floor line.

A small door in the front, or north side, led into the cellar. A window was placed in the back at the southwest corner and a concrete block chimney at the southeast corner. This chimney had a 16-inch square flue with a 16- by 32-inch opening into the cellar.

The upper story walls were built of block of the same type and size as those used in the cellar walls. Two large steel windows were located in the sides (east and west). A wooden frame and door gave entrance to the room at the front or north side. The ceiling was formed by nailing Insulite board to the rafters. The roof was framed in wood and covered with cement asbestos shingles, while metal lath and stucco were used to fireproof the eaves.

Fire Started

Oil-soaked logs placed in the basement supplied the fuel. The fire was started at 2:30 o'clock, when the air temperature was 64 degrees. It reached its maximum of 1480 degrees at 3:00 at which time the fire department turned a heavy stream of water into the basement.

Temperature readings were taken by H. C. Carroll, local combustion engineer. The temperature in the room as recorded by the maximum reading thermometer suspended in the center, midway between ceiling and floor, was 60 degrees at the beginning of the test and unchanged throughout the entire demonstration. Furniture and flowers were unaffected by the fire.

Reinforcing Exposed

A crack appeared across each of the four corners about

West elevation of the basement and-one story house erected for testing the fireproofness of a reinforced concrete floor slab and Haydite concrete block

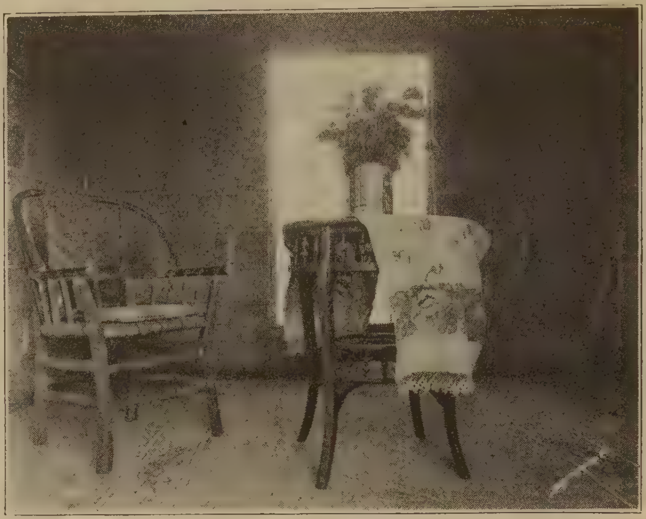
A north or front view, showing the fire getting under way

one foot out, due probably to the negative bending developed when the corners were brought in contact with the walls above by the curling action of the slab under heat. Approximately 12 square inches of spalling occurred in one spot to a depth of one inch from the soffit of the slab immediately in front of the entrance to the flue. Exposed steel at this point indicated that it did not have the 2 inches of fireproofing intended. The Haydite block showed no signs of distress.

After burning a half hour and reaching a temperature of 1480 *deg., the fire was quenched by firemen*

Degree of Heat Unusual

It was pointed out at the time of testing that a heat of 1400 degrees it not usually reached in basement fires and that the average basement is more than twice as deep as that tested, making this test an extremely rigorous one.



The interior after the fire, showing the furnishings. These were not affected by the fire. The reading thermometer suspended from the ceiling is barely visible

Haydite, produced by the Western Brick Company, Danville, Illinois, was used in the block, which were made by the Spikelmier Fuel and Supply Company of Indianapolis. The house was designed by the district office of the Portland Cement Association. These two organizations, as well as the Indiana Portland Cement Company, the Architects' Association of Indianapolis, Indianapolis section of the Indiana Engineers Society, the Indianapolis Home Builders' Association, and the Ralph R. Reeder Roofing Company sponsored the demonstration.

City and state fire officials and representatives of building and building material interests were present.

Interesting Field Tests Made of California Soils in Building Highways

California engineers of the highway department test available soils in the field to discover if they are suitable for paving foundations. The soil is tested to see how much water it will hold and to do this the various samples of soil are wet to the point of saturation and formed into narrow stick-like specimens. The samples are weighed before and after wetting in order to obtain the moisture equivalent percentage and through these means adverse soils are readily discovered by the engineer.

Lineal shrinkage tests are conducted by making the specimens into sticks and drying them in the sun on a bed of dry sawdust. After the specimen has been dried thoroughly the sticks are measured and the lineal shrinkage percentage is the difference between the wet and dry lengths.

These tests are used extensively to obtain the best results in utilizing the soils for the construction of highways.

Two Papers from American Concrete Institute Program

While this issue of "Concrete" is going to press, the Twenty-fourth Annual Convention of the American Concrete Institute is concluding its sessions in the Benjamin Franklin Hotel at Philadelphia.

Because of this fact, it is not possible to give our readers an account in this issue of the many interesting and helpful papers and discussions on the Institute program. That must be deferred until the April number.

But we are able to present to our readers on the following pages two papers that were read during the Institute sessions.

One of these is of particular interest to concrete contractors; the other to concrete products manufacturers.

Every session of the program has been crowded with material of interest to every concretor, regardless of his particular specialty.

All this will be brought to you in your April issue of "Concrete."

Experience With a Strength Specification Contract

By ROBERT C. JOHNSON*

A Detailed Description of the Methods Used on a 22,000 Cubic Yard Quality Controlled Concrete Job in Wisconsin—Tests Check Quality of Concrete Secured—Quality Control Brought Savings in Cement, Aggregates and Labor

IN July, 1926, construction was started on a large factory addition in the Middle West. There were no material dealers or labor unions in the community so all material and labor required for construction work had to be brought in from other communities. The factory site being located close to the west shore of Lake Michigan has a very changeable climate, and cold weather may be expected any time from early October to April. The fall months are usually very rainy.

Construction work was divided into two units, the first consisting of two kiln foundations 400 ft. long by 50 ft. wide and two tunnels 125 ft. long by 40 ft. wide by 20 ft. deep. Plans required 10,000 cu. yd. of excavation and 6,000 cu. yd. of concrete divided up between 1:2:4, 1:3:5 and slag. The second unit consisted of two buildings, one 940 ft. by 200 ft. one story high, and the other 340 ft. by 80 ft. five stories high. The plans called for 150,000 sq. ft. of ground floor slab and 118,000 sq. ft. of reinforced flat slab. The five story section had a 22-ft. basement and floating foundations; 40,000 cu. yd. of excavation and 16,000 cu. yd. of concrete were required for this work.

Contract Awarded

Early in July representatives of five construction companies were called into consultation at the owner's office and shown a set of plans covering the kiln foundations. After being allowed fifteen minutes to check roughly over the drawings, bid forms were submitted to the contractors and they were requested to fill in unit prices for labor opposite the estimated quantities shown on the form. It was explained to the bidders that the owner would purchase the materials, except form lumber and nails, which were to be included in the unit prices submitted by the contractors. The Immel Construction Company was 50 per cent low on their proposal which was accepted at once. As the plans were not complete for the building unit, the Immel Construction Company immediately submitted unit prices covering labor for foundations for this unit and again later submitted unit prices for all concrete work involved in the superstructure.

The units were accepted and contracts were signed for all of the concrete work involved in the construction program. Bids were then taken by the owner for cement, sand, gravel, and reinforcing steel. As the prices of the materials are entirely standardized in this territory, the Immel Construction Company bid a few cents under the market to obtain orders for all materials. This was done to guarantee a continuous flow of materials to the job so there would be the minimum amount of lost labor.

The construction company now had contracts with the owners involving unit prices for labor on the kiln foundations, additional and different unit prices for labor on the building foundations, and a third set of unit prices for labor on the superstructure making altogether 95 separate figures not including the prices for materials f.o.b. cars. To simplify the checking of materials and labor it was decided to change the cement, sand, and gravel prices to prices per yard of concrete and combine these with the labor units.

Taylor & Thompson's tables of quantities based on 45 per cent voids were used for this purpose. Having arrived at prices per cubic yard of concrete in place for different mixes, representatives of the Immel company explained to the owner that material had been sold at a loss of about 40 cents per yard of concrete and asked that the specifications be changed from 1:2:3 mix which was too rich for a 2,000-lb. concrete to a 1:2:4 mix. This was done and the yard price for materials was reduced. As labor prices remained the same, the contractor picked up a saving by this change.

It was then proposed by the construction company that they be permitted to use any mix that would produce a 2,000-lb. concrete for the 1:2:4 mix or a 1,500-lb. concrete for the 1:3:5 mix. This was agreed to and clauses were inserted in the contract releasing the construction company from the architect's specifications but penalizing them the amount of the saving in material on any yardage of concrete that might test below 2,000 or 1,500 lb.

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*Immel Construction Co., Fond du Lac, Wis.

Very little leeway was left for the selection of materials as the brand of cement to be used was specified by the owner and the low price of local aggregates controlled the supply of sand and gravel during the warm months. After the local pits froze up, it was necessary to obtain aggregates from any available stocks. As average conditions prevailed among the local gravel pits, it was necessary to check carefully the grading, as none of the pits were used to working under a rigid specification.

Since the type of contract was highly experimental with the construction company, expense was the controlling factor in the selection of equipment. The only new machines purchased were very inexpensive weighing hoppers.

Because of the large area covered by the foundations and buildings it was decided to have centralized control of the proportions with small mixers distributed over the job. This greatly simplified the work of the inspectors and engineers. Immediately upon receiving the contract the construction company hired Mr. Timms of the Portland Cement Association to take entire control of the proportioning of mixes and to be entirely responsible for strengths. The general superintendent was given a clear understanding of the importance of the strength of the concrete and was made to realize that Mr. Timms was in absolute control of the proportioning of the material. The superintendent's greatest problem was to iron out differences between Mr. Timms and the concrete foremen who objected to the new methods. A responsible material clerk was placed in charge of the delivery of materials, the checking of quantities used, and the figuring of the units of work completed. Mr. Timms was the only extra employee required for this type of contract.

Job Methods

The various factors affecting the strength of the concrete at 28 days were considered and controlled as follows:

1. Cement—Quantity checked by weighing hoppers.
2. Water—Quantity checked by automatic tank, and slump test.
3. Mixing time—No rigid control.
4. Temperature—Heating before and during mixing and after placing.
5. Test methods—Not carefully checked at start of job. Later corrected.

The following methods of handling material and concrete were used: Cement, sand, and gravel were all received on cars at a siding about 1,500 ft. from the job. Cement was unloaded into a cement shed of about three-car capacity. Sand and gravel were unloaded by clamshell into bins and stockpiles. During freezing weather steam nozzles were used to thaw out the cars and to keep material from freezing in the bins. A large marine boiler supplied steam at this location.

Aggregates were weighed into batch dump trucks, the cement being placed on top. On very windy days this resulted in a loss of some cement before the material arrived at the mixer. Materials were handled in various ways at the different mixers. One 7-S mixer used for pouring ground floors was continuously moved around. The aggregates were hauled to this mixer during bad weather or while the 14-S mixers were not working. This material was stockpiled and delivered into the mixer by wheelbarrows. One 14-S mixer used for pouring the kiln foundations received pre-mixed material delivered to the skip. Another 14-S mixer was set at the base of a hoisting tower and poured 2,000-lb. concrete delivered dry mixed by the trucks. As these two mixers were pouring different proportions, it was necessary to have the drivers of the trucks wear different hats so the man at the weighing hoppers could tell which mix to weigh into the trucks.

Material leaving mixers was also handled in different ways. The one-bag mixer usually dumped into wheelbarrows or direct into place. The moving two-bag mixer dumped either into two-wheel carts or directly into the forms. The stationary two-bag mixer delivered all material into a tower bucket dumping into a tower hopper and chutes. Part of this concrete was delivered from the chutes direct into forms and part into a floor hopper and two-wheel carts. During freezing weather an additional boiler was used at the stationary two-bag mixer to heat mixing water and to run a steam line down the chutes which were entirely enclosed.

Various test strengths were obtained due to the variation in the methods of handling materials both to and from the mixers. The one-bag mixer which had no control except the slump test gave results as follows: Slumps varied from 1½ in. to 3 in. with strengths from 1,600 lb. two samples to 3,400 lb. two samples, 24 samples between 2,200 and 3,100 lb. Most of the material handled by this mixer was to pass a 1,500 lb. test. (See Fig. 1.) The moving two-bag mixer which had only weighing and slump test control gave the following results: Slumps varied from 4 in. to 8 in. and the strengths from 1,300 lb. one sample to 2,400 lb. one sample, 17 samples 1,460 lb. to 2,300 lb. (See Fig. 1) The largest volume of concrete passed through the stationary two-bag mixer with the following results: Slumps varied from 4½ in. to 9 in. averaging between 6 and 7 in.; 90 per cent of all samples were above 1,900 lb., 80 per cent of all samples were above 2,000 lb., 50 per cent of all samples were above 2,200 lb., and 30 per cent of all samples were above 2,500 lb. The average of 76 samples was 2,280 lb. (See Fig. 2.)

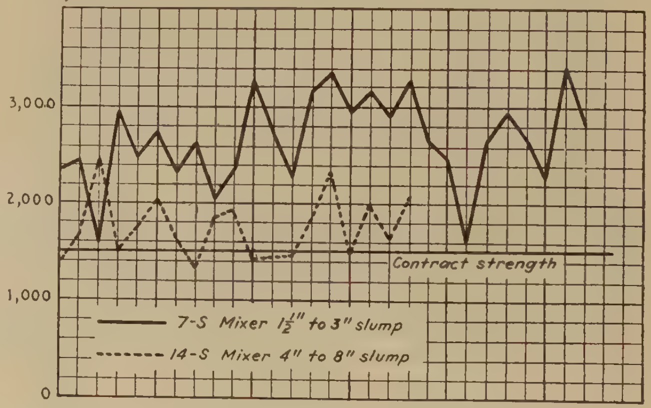


Fig. 1.—Test results on concrete of different slumps and handling methods

Only 7 of the 76 samples fell below 90 per cent of the designed strength. Seventy per cent of all samples were between 1,900 lb. and 2,500 lb. All test samples as recorded above were stored under job conditions. The greatest variations in strength were caused by the temperature in storage conditions. Of 10 test columns made from five samples, five were stored inside and five outside. The samples inside averaged 620 lb. stronger at 28 days than the samples stored outside. (See Fig. 3.)

It was also found that numerous samples were improperly stored at the laboratory after being shipped from the job. After this condition was rectified, there was less trouble with low strengths. As a comparison of the strengths obtained on this contract and those which may be looked for under similar conditions, the results may be compared with the Portland Cement Association Building on which 13 per cent out of 34 samples fell below 90 per cent of the designed strength whereas as noted above only 7 of 76 samples fell below 90 per cent of the designed strength on this contract.

A subsequent contract for the Kohler Company started in January and completed in February under the same units and same specifications showed the following results: Sixteen samples were taken having an average strength of 2,707 lb., none fell below 2,000 lb. This concrete was poured with the same mix as the rest but the samples were all stored inside. (See Fig. 2.) As an interesting sidelight and to settle the question as to whether our concrete was being mixed long enough, the average mixing time being 45 seconds for the stationary two-bag mixer, 5 samples of concrete were taken at the mixer and 5 samples from the same batches were taken from the floor hopper.

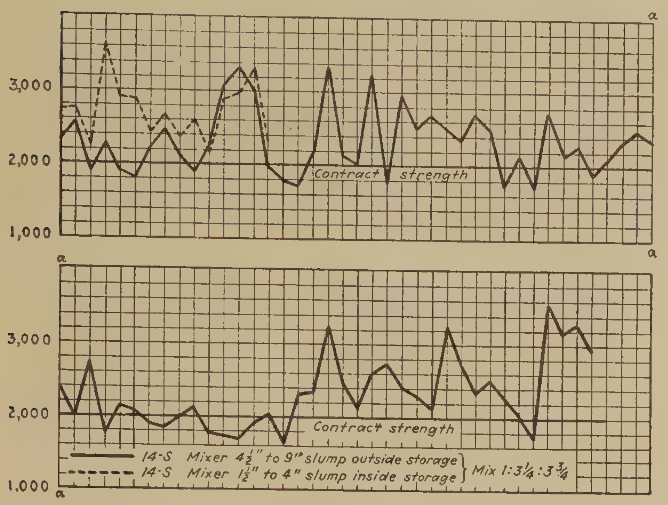


Fig. 2.—Relation of actual to designed strength

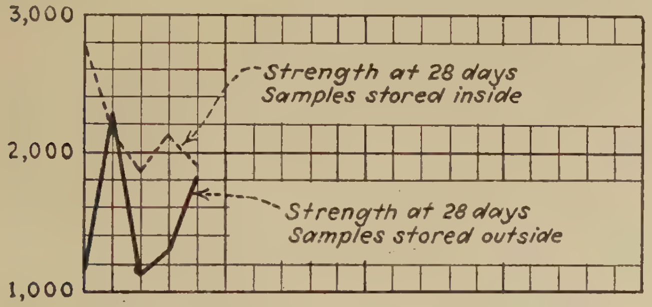


Fig. 3.—Strength comparison of five-column test samples stored inside and outside

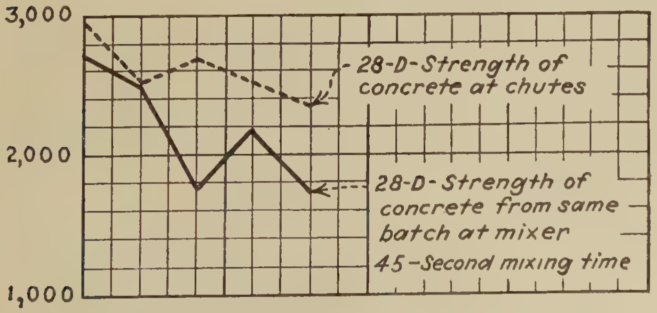


Fig. 4—Strength comparison of five samples at mixer and at floor hopper

The 5 samples from the floor hopper averaged 435 lb. stronger than the samples taken at the mixer showing that there was considerable justification for our claim that the handling of the concrete between the mixer and the forms resulted in additional mixing equivalent to leaving the material in the mixer 30 seconds longer. (See Fig. 4.)

The actual savings made on this contract were: Cement approximately one bag per cubic yard of concrete poured, aggregates 10 cents per cubic yard of concrete poured, and labor approximately 50 cents per cubic yard of concrete poured. This overcame the loss in the sale of materials below cost. Below are given computations to show the savings that may be expected from the use of a strength specification contract. For the purpose of comparison a type of plant layout has been assumed similar to that used on the Kohler contract. These computations are self-explanatory.

Analysis of Strength Contract Economies

1. *Assume type of equipment lay-out*
   - Aggregate bins
   - Weighing hoppers
   - Trucks
   - Cement shed
   - Two-bag mixer
   - Tower and chutes
   - Buggies
2. *Assume Labor and Material Rates*
   - Cement, $2.19 per bbl.
   - Sand, $1.40 per cu. yd.
   - Stone, $1.535 per cu. yd.
   - Common labor, 45c.
   - Skilled labor, 75c
3. *Cost of Concrete as Originally Specified*

A. Resume of Specifications
Mix 1:2:3 1 bag cement = 1 cu. ft.
Slump 6 in. to 7 in.
Time 1½ min.

B. Analysis Material Costs
Cement, 1.67 bbl. × 2.19 = 3.6573
Sand, .50 cu. yd. × 1.40 = .70
Stone, .74 cu. yd. × 1.535 = 1.1359

Total .... 5.4932 = 16.2 cu. ft. per bbl.
8.1 cu. ft. per batch

C. Analysis Labor Costs
1 Foreman ....10 × 1.35 = 13.50
1 Clamshell operator..10 × 1.25 = 12.50
2 Clamshell laborers....20 × .45 = 9.00
1 Weighing man........10 × .50 = 5.00
1 Bin laborer........10 × .45 = 4.50
2 Cement men........20 × .50 = 10.00
3 Truck drivers........30 × .50 = 15.00
1 Mixer engineer........10 × .75 = 7.50
1 Mixer laborer........10 × .45 = 4.50
1 Hoist engineer........10 × 1.25 = 12.50
1 Tower man........10 × .60 = 6.00
5 Buggy men........50 × .45 = 22.50
3 Spaders........30 × .45 = 13.50

146.00
Liability Insurance 7.30

Total .... $153.30 per 10-hr. da.
Allow 2½ min. per batch = 240 batches per 10-hr. day
240 × 8.1 = 1,944 cu. ft. per day = 72 cu. yd.

$\frac{153.30}{72}$ = $2.13 per cu. yd. labor
5.50 per cu. yd. material

$7.63 per cu. yd. total

4. *Cost of Concrete as Poured*

A. Analysis Material Costs
Cement, 1.25 bbl. cement × 2.19 = 2.7375
Sand, .56 cu. yd. sand × 1.40 = .7840
Stone, .74 cu. yd. stone × 1.535 = 1.1359

4.6574 21.7 cu. ft. per bbl.
10.85 cu. ft. per batch

B. Analysis Labor Costs
Same crew as above = \$146.00
Mix engineer = 14.00
\$160.00
Liab. Insurance 8.00
Total \$168.00
Allow 1¾ min. per batch = 343 batches per 10-hr. day
343 × 10.85 = 3721.55 cu. ft. per day = 137.83 cu. yd.
$\frac{168.00}{137.83} = 1.22$ cu. yd. labor
4.657 cu. yd. material
\$5.88 cu. yd. total
Specified concrete cost = \$7.63
Contract concrete cost = 5.88
Saving .... \$1.75 per cu. yd.
Part of this saving was given to the owner by changing basis of contract from 1:2:3 mix to 1:2:4 mix so it represents more than the total saving per cu. yd. as made by the contractor.

Comparison of Jobs

As a comparison of the results that might have been expected for the concrete as originally specified and for the results as obtained, there are unfortunately very little test data. However, during the months of February, March, and April a different organization poured concrete for a superstructure for which we had poured the foundations in January. The superstructure was built in accordance with the specifications as originally drawn for the pottery unit. Four samples of this concrete were taken, the methods of sampling and storing being the same as for the foundations. The average of these four samples was 2,495 lb., whereas the average of the 16 samples taken from the foundations poured under the strength contract was 2,707 with none falling below 2,000 lb.

To obtain the maximum economy under any strength contract, curves should be worked out for the plant setup and the most economical ratio should be obtained for mixing time, labor cost and material cost. A short mixing time necessarily means more cement and less labor, so the most economical and practical ratio between the material and labor costs should be determined for each job. It would be proper to take five samples with five variations of cement content for each of the following mixing times: 45 seconds, one minute, one minute and 15 seconds, one minute and 30 seconds. In running these job control tests the water-cement ratio should be maintained practically constant. Having obtained the results of these tests it is a simple matter to determine the most economical mix by comparing the total cost of concrete per yard for each mix based on an average daily output for each mixing time. It is the opinion of the writer contrary to the belief of the average contractor that the most economical ratio is obtained with one minute and 30 seconds mixing time.

Conclusions

This particular contract was naturally very satisfactory both to the owner and to the contractor. A concrete of satisfactory strength was furnished the owner at a cost less than would have been required by following the specifications whereas at the same time the contractor had absolute control of the methods of manufacture. There was a greater spirit of co-operation between the inspectors and the contractor's organization in trying to obtain a given result than there would have been had the inspectors been merely trying to enforce a rigid specification. It was quite apparent that there are no definite and accepted standards for the measurement and manufacture of a given strength concrete. Where a spirit of co-operation is built up between the designer and manufacturer, there is not as much reason to worry about the quality of concrete as there is if a continual struggle exists to enforce in some cases an unreasonable specification.

There are economies of design and construction which will make the strength manufacture of concrete a necessity of the future. To meet this situation a committee of the American Concrete Institute should clarify the following points:

1. What standard should be used for the measurement of concrete strength.
2. What over- and under-run should be permissible due to the methods of testing strength.
3. What is an equitable form of contract to guarantee results.
4. What would be the most economical methods to use in the production of strength concrete.

The question about strength of concrete today is not whether we want it but how can we handle it?

Specifications for Concrete Stone

By C. VAN DE BOGART

Cast Stone Manufacturer Tells of Need for Standard Specifications for Cast Stone—This and Other Problems Confronting Manufacturers Can Best Be Met Through a Cast Stone Manufacturers' Association

THE Economy Concrete Company joined the American Concrete Institute for two reasons: First, to gain current knowledge of making concrete in other ways than of the concrete stone industry because we realize that the fundamentals of good concrete are the same no matter where or how made, placed or used, and that these fundamentals are important in making our cast stone. Second, to establish better acquaintance and understanding with other manufacturers of concrete stone through convention contacts and other means possible in this organization.

Back of these objects was the conviction that the concrete stone manufacturers who last year marketed products whose estimated value was more than \$50,000,000, should have an association all their own. This is with no thought to duplicate the excellent work of this Institute from which the stone manufacturers must benefit, but to accomplish other things in the adjustment of relations in the concrete stone industry and the raising of the standards of that industry in ways which are properly the work of a trade association and not of a technical society.

Standard Specification Needed

First of all, it seems, among the needs of the concrete stone industry is a standard specification—a statement of the nature and characteristics of the product we are making. Such a specification should come from the American Concrete Institute through the work of a committee on which both producers and users—manufacturers, engineers, and architects—are represented.

Because the stone manufacturers have, in general, only begun to have a new group consciousness, a feeling that they must work together, there is a little apprehension that they will find it hard to settle upon a specification which can be generally accepted but perhaps they can make some progress among themselves which will make for proper committee procedure, if they thresh out in discussion among themselves some of the preliminary steps. That is why, it seems, an association of stone manufacturers is right now important.

No Institute committee should undertake the specification problem unless there is some hope of general agreement. My purpose here is merely to outline the need, doubtless what is already in many of your minds. If now, out of a discussion we may get no further than to agree to attempt an agreement it will be gratifying progress. It must first be decided that we do, or do not, want more unity and group cohesion among manufacturers of concrete stone, and a dependable minimum standard of quality. If we do seriously want these things and recognize their importance, we may all be in better humor to compromise our minor differences for the sake of our agreement in the major object.

As a matter of a trade association does not properly come before this Institute, I will now confine myself to the subject of specifications, although eventually I believe a manufacturers' association could help not only in perfecting them but in maintaining them after they have been adopted. Some manufacturers perhaps view this subject as a personal matter. They may feel that conditions properly vary with locality. However natural this conclusion may seem, it is becoming increasingly apparent that the specification subject is distinctly a group problem and that it must be solved in order to meet the request of architects, and others, for specification data from the American Concrete Institute.

Fundamentals of Cast Stone Manufacture

It should not be difficult to convince any concrete stone manufacturer, regardless of the nature of his particular product, that the fundamentals of his good concrete are identical not only with the fundamentals of every other manufacturer of concrete stone, but with the fundamentals of good concrete however made or placed. It is this which establishes our position in this Institute and makes our interests in those fundamentals identical with the interests of all other members, and it also establishes our own special community of interest as manufacturers of concrete stone.

Whatever special operations we may have in proportioning, mixing, conveying, placing, curing or surface treatment, no matter how these vary in detail of conditions, we are all producing something which is subject to like laws of expansion, contraction, to crazing, to the use of color and other admixtures and involving the same rules of physics and of chemistry and subject to the same destructive influences. Obviously, we have a common ground of interest.

It is a well-established fact that a specification in the construction field (or perhaps anywhere else) should be, to do what is expected of it, the joint effort of manufacturer and user.

Otherwise, it doesn't mean anything to architects and engineers who may be expected to specify the material. It must, to command the respect of building authorities, come from an organization which gets its scientific standing from the fact that the maker and the user sit down together. When it comes to a recommended practice as distinguished from a specification, the manufacturer has much more to say. The former says how it shall be made and the latter says how it shall perform and what its characteristics shall be.

The demand for standard specifications most assuredly exists and in searching for particular reasons for their existence several can readily be discovered. It seems therefore particularly fitting to me that we should avail ourselves of the opportunity existing through our connection with this Institute in whose membership we have so many specialists, at least to lay a foundation for a specification which will not only improve our product but promote a reasonable degree of confidence that our product will be well handled and placed after passing from our own hands to that of the builders who will use it.

A specification for concrete stone must necessarily be divided under two headings: First, the characteristics of the stone itself; second, the result after setting and pointing.

Value of a Standard Specification

Much faulty practice exists today in manufacturing concrete stone. While a specification will not directly correct poor manufacturing practice it will do so indirectly by creating a standard of quality which must eliminate poor practice. A poor product anywhere lowers the public esteem for the whole class of products to which it belongs.

A makes good stone. *B* makes inferior stone. *B* trades on the reputation of *A*, and *A* loses by the bad reputation of *B*. That is what it means to have an industry without a standard.

Many of us are familiar with the distribution of propaganda by interests with which we are in competition, and their scrutiny has extended completely across and up and down the country. They have rewarded themselves and wrought much damage to the cause of concrete stone through their efforts.

They have found many instances where the composition of concrete stone has been of the most inferior of aggregates with no thought of producing a pleasing color, and a surface finish comparable to the trowelled surface of a sidewalk. Shall such material establish the public's rating of the fine product others are making?

Buildings are found trimmed with stone showing a lamentable lack of reinforcement, with many pieces showing large cracks and superimposed loads grinding away daily at their task of breaking down the stone work.

Other work clearly shows that improper delivery and storage methods at the job sites, together with general careless handling and shipping of material, sometimes cast only a day previous, also exert an injurious effect on the final appearance of the material and in all cases leave glaring and unsightly patches and repairs to further unfavorably influence the use of this product in which we are all so much interested.

These things and other items such as intelligent and carefully prepared setting plans; co-operation on structural details with the builder and architect; facilities for testing, and the careful planning of the delivery procedure, unless ably handled by the manufacturer, also lessen the value of concrete stone as a desirable material to use.

Evils of Improper Setting

When concrete stone is carefully manufactured, delivered in good order in well-made pieces at the building site, the manufacturers, architects, and owners are not yet assured of a gratifying result. The results of setting and general misuse by mason contractors is the most disappointing feature which I am familiar with, and I am firmly convinced that sooner or later the industry from necessity will be obliged to institute an educational program among the architects and builders to overcome such methods as are now practiced.

It is illogical, but is nevertheless true enough, that if a masonry structure trimmed with cast stone is not watertight, it seems prima facie evidence that the stone is at fault and the manufacturer of it is immediately placed in a defensive position; obliged to expend both much time and money in investigating the condition of the building. Usually he is successful in locating some other cause for the trouble.

It takes generally a very inferior piece of concrete actually to leak water, but the most nearly waterproof material, if not tightly set together at the building, according to the approved practices, will be no better than the mortar which binds it together.

Pointing and protection of the stone are two other important items and too great care cannot be exercised in either case, especially with pointing. Many buildings would appear to far better advantage properly pointed, and not the least important is the final cleaning down of the work which is done best only when done properly.

Why then should we expect to have our work acceptable in the highest degree when the only likelihood of doing so is when we have a perfect combination of architect, builder, manufacturer and owner—combining a knowledge of what to specify—how to manufacture—how to erect—and what to pay for?

This is our only expectation of improvement and it cannot be hoped for until we ourselves consider carefully how best to overcome the conditions which defeat the purpose.

Some apprehension may exist as to our ability to adopt a specification which would apply to wet-cast and dry-tamped stone, but my judgment leads me to believe that it can be accomplished. At least in the effort, we would be parted from nothing except a little time and a few opinions.

Concerted Effort Necessary

The many considerations already stated in conjunction with the amount of capital invested, the years of expensive experience, and the constant study to improve our product, make it almost a necessity that we take the next steps—a concerted movement, with the greater force of united effort over many unrelated individual efforts on the part of all those anxious for progress, advancement and proper development of the industry.

In my opinion, and I submit it to you for your consideration, there are two things to be done—adopt standard specifications through the American Concrete Institute and for work preliminary to that, and to supplement and to thoroughly establish those standards where adopted, the organization of the concrete stone producers, into a group association in which and through which we may undertake to correct the haphazard conditions of our industry. Let us not fail to balance the advantages of a standard specification against any possible shortcomings and if there is sufficient evidence in favor, set up a preliminary organization to formulate plans and method of procedure with the view of improving our position and our product.

Historic English Bridge To Be Replaced by Modern Concrete Structure

The demolition of the famous Old Bridge at Bath, England, is now seriously contemplated. If the present plan is carried out, which seems highly probable, it will be replaced by a modern reinforced concrete structure. The city council is now actively considering this plan.

The subject is causing much discussion in the west of England in view of Minister of Health Chamberlain's public pronouncement recently that the Bath Corporation Act, 1925, contains useful provisions for preserving buildings of historical or architectural interest in the city. Some time ago a scheme for widening the old bridge received the approval of Parliament, for owing to the increased traffic it was found necessary to provide greater traffic facilities over this bridge across the River Avon. In preparing the necessary plans for this work it was necessary to gain accurate information as to the structural conditions of the existing bridge. This examination has disclosed such an unsatisfactory state of affairs that an entire demolition and replacement is necessary.

Formerly Widened

The Old Bridge is a composite structure which has been widened three times, twice in stonework and once in cast iron. It is extremely doubtful whether there is any of the old original bridge surviving. When the new bridge is constructed it will be a suitable companion to Pulteney Bridge, which is an architectural criterion of Bath.

A similar fate and replacement awaits another historic bridge. After a good many years of agitation the Cumberland and Westmoreland county councils have come to an arrangement by which in certain circumstances one of the oldest bridges in the English lake district will be removed and a larger one substituted of reinforced concrete. Eamont Bridge, which connects the counties of Cumberland and Westmoreland and stands in the two parishes of Penrith and Barton, is four miles below the River Eamont from Ullswater.

Eighteen Feet Wide

The bridge carries the whole of the main road traffic between the south and Scotland, yet it is only 18 feet wide, with an arch in the middle, and on the north side there is a sharp drop before rising for the steep bank. The two counties will share the costs in the proportion of four-fifths by Cumberland and one-fifth by Westmoreland, but the success of the scheme is contingent on a grant of at least 50 per cent being made by the Ministry of Transport. The cost of the new bridge is officially estimated at £40,000 ($200,000). It will be 50 feet wide and the dip on the Cumberland side will be filled. A number of houses will have to be purchased for the purpose in order to abolish what is now a dangerous junction. The proposal is to retain all the stones from the present bridge and use them for parapets and in other ways in the new structure so as to reduce the sense of newness to a minimum and as far as possible preserve its historic associations. Excavations which have been made show that the fabric is perfectly sound, though at one point there has been a slight sagging.

Correction

When the paper, "The Application of Reinforced Concrete to Structures," by Wm. F. Zabriskie, was published in the February issue of "Concrete," we neglected to state that the paper as published was an abstract of the paper presented by Mr. Zabriskie at the Annual Meeting of the Michigan Engineering Society, November 11th, 1927.

The entire text of the paper as presented was published in the December, 1927, issue of "The Michigan Engineer," the official organ of the Michigan Engineering Society.

Effect of Shape and Character of Coarse Aggregate on Strength of Concrete

An Account of Tests Made by the Minnesota Highway Department with a Variety of Aggregates to Determine Their Behavior in Concrete—Water-Cement Ratio Held Constant for All Aggregates

By F. C. LANG
Engineer of Tests and Inspection, Minnesota Department of Highways

THE relative value of different types of coarse aggregates for use in portland cement concrete has always been a controversial subject. This has been especially so for concrete pavements. Concrete in pavements is put to a more severe test than in practically any other place that concrete is ordinarily used. Aside from resistance to abrasion and disintegration from the elements, the concrete is subjected to alternate tension and compression from traffic and temperature changes. At the present time concrete pavements are usually designed according to the transverse strength by formula developed from the Illinois Bates road test and others, although it is realized that high compressive strength is also essential.

Tests

In order to gain some further information on local materials, the Minnesota Highway Department made some tranverse and compressive tests using the following five distinct types of coarse aggregate.

No. 1. A smooth waterworn gravel largely composed of igneous rocks from northern Minnesota. All flat, elongated, and broken pieces were picked out by hand. See Plate No. 1.

No. 2. An ordinary commercial gravel containing crushed oversize from St. Paul, Minn. See Plate No. 2.

No. 3. A crushed limestone. See Plate No. 3.

No. 4. A crushed trap rock. See Plate No. 4.

No. 5. A crushed sandstone. Per cent loss abrasion test 11.1. One-half hour absorption 3.13 per cent. See Plate No. 5.

Beams and Cylinders

Using the same volumetric proportions (1:2:4) measured by weight, and making cement, sand, grading, water (with allowance for one-half hour's absorption), and curing the same for all specimens, nine 6 by 12-in. compression cylinders and nine 6 by 6 by 30-in. beams were made for each kind of coarse aggregate.

Plate 1

Plate 2

With the same water-cement ratio the slumps for the various aggregates were as follows:

	Inches
No. 1 Smooth gravel	6⅝
No. 2 Commercial gravel	4¾
No. 3 Limestone	4
No. 4 Trap	2¼
No. 5 Sandstone	4⅝

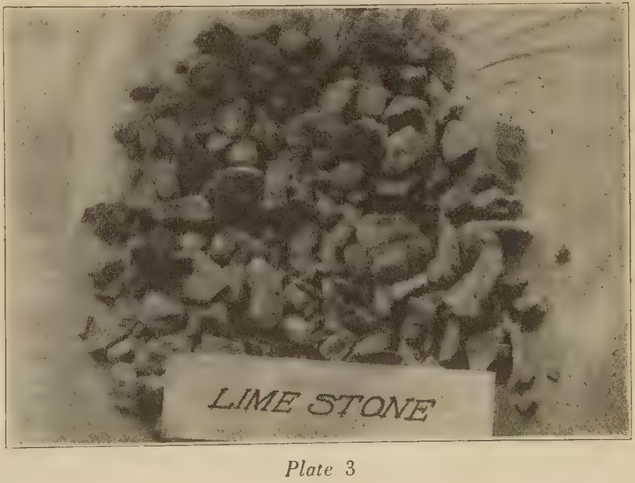


Plate 3

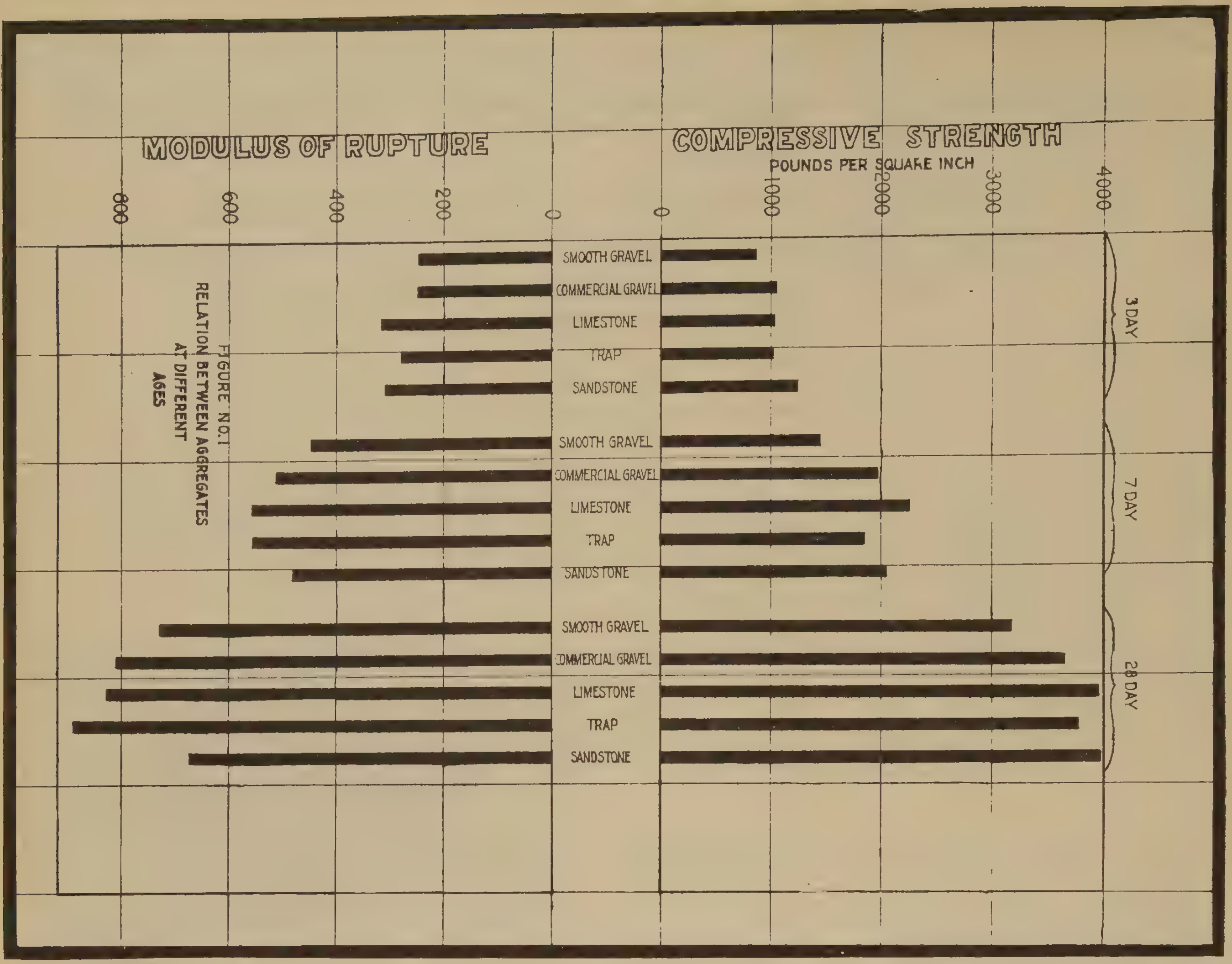


Figure 1

The results of compression and transverse tests are shown graphically on Figure No. 1. It will be noticed that the smooth gravel is lower in both tests. The most important item shown by these tests is, I think, the low twenty-eight day results shown by sandstone in the transverse test. It would appear from these results that for the same maximum load, pavements constructed with this type of coarse aggregate would fail on account of corner breaks unless made thicker. This is not shown by compression test.

Plate 4

Plate 5

Less Water

The slump test indicates that the smooth gravel could be used with less water. This should result in higher unit strengths.

There was also some difference in yield that should be given consideration in a final analysis of these figures.

The A. B. C.'s of Good Concrete

Some of the Factors That Affect the Quality of Concrete —Strong Concrete Can be Secured at Earlier Ages With Standard Portland Cements — The Factors That Speed Strength Increases

Part VII—High Early Strength Concrete

In previous issues a number of the factors that influence the quality of concrete have been explained. We have seen how mixing water, time of mixing, proportioning and curing all have a definite effect on the kind of concrete secured.

But *time* is often an important item on many jobs. It is often necessary to make concrete that can be put in service, say, three days after it is placed. How this can be done with ordinary portland cement is the subject of this chapter in these articles on the A. B. C.'s of Good Concrete.

HIGH early strength has, in the last year or two, become of increasing interest to concretors. And it is natural that it should. Time is an important item on new work as well as in repair work. High early strength concrete meets a definite need.

It is natural that methods for obtaining high early strengths should follow the growing knowledge among concretors of the principles for making better concrete as brought out in previous articles in this series. There is nothing mysterious in the process. High early strength concrete is simply the result of the application of all those principles discussed in these articles. This chapter will point out how early strengths can be secured by using standard portland cements. It does not take into account the use of special portland cements, though the methods described will hasten the hardening of concrete regardless of the particular qualities of the cement used.

Factors Influencing Early Strength

Here are the seven principal factors to be considered when high early strength concrete is desired:

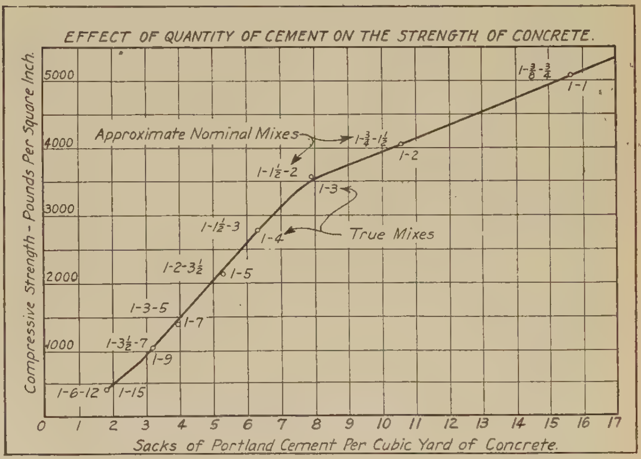
1. Decrease the amount of mixing water.
2. Use more cement.
3. Increase the mixing time.
4. Place concrete at a temperature of at least 70 degrees F.
5. Keep the concrete at this temperature during the early curing period.
6. Follow the principles of proper curing.
7. Use calcium chloride as an admixture.

Tests and practical experience in the field have shown that when these requirements are met it is possible to speed up the process so that strengths up to 2500 pounds per square inch are secured at 3 days. If you succeed in increasing the strength of the concrete at 28 days, it naturally follows that the earlier strengths will also be increased. That is exactly what is done when high early strength concrete is secured.

Results of Careful Control

A previous article has pointed out how mixing water affects the strength of concrete. It has been shown that an increase of only one per cent of water reduces the strength of concrete at one and two days as much as 5 per cent. Less water can be used per sack of cement when the cement content is increased without affecting workability because the total amount of water in the batch will not be lowered.

An accompanying chart shows how increasing the amount of cement increases the strength of the concrete. The influence of mixing time on the strength of concrete is more pronounced when rich, dry mixes are used as is the case when high early strength concrete is desired.



An increase of from 1 to 2 minutes in mixing time will increase the compressive strength of concrete 10 per cent at 3 days. A 5-minute mixing period increases the strength 15 per cent.

Other Helps

The effect of chemical admixtures such as calcium chloride, Cal, or other materials of a similar nature in hastening the hardening of concrete has been demonstrated in many laboratory tests and on many jobs. It is important that the admixture be properly combined with the materials in the mix and that the correct amounts are used.

It is advisable to make field tests, if possible, using the materials that are to enter into the job, to ascertain their effect on the concrete to be placed.

Of course, it is especially necessary to see that all other factors such as proportioning, type and cleanliness of aggregates, placing and curing be carefully watched if high early strength concrete is to result. Early strengths can only be expected when all these requirements are met and when the special precautions are observed.

Example of High Early Strength

In order to illustrate the effect of the various factors that hasten the hardening of concrete, the following tests are presented. We take, for comparison, an ordinary field mix of 1:2½:4. This mix requires about 1.32 barrels of cement per cubic yard of concrete. Using 7.8 gallons of water per sack of cement and a slump of from 6 to 7 inches, a 3-day strength of 750 pounds per square inch was secured. Now notice how this 3-day strength increased as the various factors described above were applied:

Field Mix	Cement Required per cu. yd. of concrete	Slump (inches)	Water (gals. per sack of cement)	Time of Mixing	Compressive Strength at 3 days (lbs. per sq. in.)
1:2½:4	1.32	6-7	7.8	1	750
1:2½:4	1.32	1	6.1	1	1350
1:1½:2½	2.03	1	4.4	1	2410
1:1½:2½	2.03	1	4.4	5	2860

The first horizontal line in the table shows the facts regarding the mix mentioned above. Now we cut down the amount of water used per sack of cement from 7.8 gallons to 6.1 gallons. All the other conditions remain the same, except that the slump changes from 6 inches to 1 inch and the 3-day strength is increased from 750 pounds per square inch to 1350 pounds per square inch.

In the next line, a richer mix is used and the water content is cut to 4.4 gallons per sack of cement. The slump remains the same because the cement content was raised from 1.32 to 2.03 barrels per cubic yard of concrete. The mixing time is still 1 minute, but the 3-day strength has been increased to 2410 pounds per square inch.

The last line of the table illustrates the effect of increasing the mixing time from 1 to 5 minutes. All conditions except the mixing time are the same as in the line above, yet the 3-day strength was increased to 2860 pounds per square inch.

Now, if about 2 per cent of calcium chloride were added, the 3-day strength would increase still more until the resulting 3-day strength would be approximately four times as great as it was under the conditions shown in the first line of the table.

By following the methods outlined in this chapter, any concretor can hasten the hardening of the concrete he places and will, incidentally, also secure a better concrete at all ages. Whether or not it is economical to observe one or all of the features that increase the early strength of concrete depends upon the job in hand and on the advantages that result.

British Woman Engineer Makes Concrete

The first woman member of the Institution of Quarry Managers of Great Britain is Mrs. Greaves, who superintends her works and office, which are in Yorkshire. Mrs. Greaves acts as her own saleswoman, produces concrete blocks, and has a small crushing plant for breaking up pebbles. In addition to all these activities she manufactures artificial stone equal in strength and appearance to natural stone. She has supplied the material for many jobs in Yorkshire, and has recently secured the contract for the whole of the stonework in a big infirmary. Mrs. Greaves is a prominent member of the Women's Engineering Society of Great Britain.

Pennsylvania Railroad Uses Concrete Ties

Preliminary tests with concrete railroad ties have been so satisfactory that the Pennsylvania railroad is now installing 25,000 of them over main line tracks, east of Pittsburgh. These ties are enough for seven and one-half miles of track.

Although experiments have been conducted with concrete ties for a score of years, and although numerous patents have been granted, this is the first real important consideration that has been given such ties, railroad officials point out.

Oak ties which the railroads use largely are becoming more and more expensive. This has forced railroad officials to look about for some substitute. The versatility of concrete probably makes this material preferable. In constructing the ties used by the Pennsylvania lines, steel longitudinal reinforcing bars are used. At each end of the tie a wooden block is inserted so that the rail may be spiked down. It is believed that the cost of making such ties will be quite reasonable when produced in large quantities. Engineers are also of the opinion that concrete ties will last almost indefinitely.

The Pennsylvania railroad is keeping an accurate check on maintenance costs, placement costs, the riding qualities and the wear on rolling stock over the rails resting on concrete. The results of the Pennsylvania experiments may justify the extensive use of concrete ties. Railroad men have expressed the opinion that the trains of the future, equipped with roller bearings, will run at extremely high speed over concrete roadbeds or ties.

Ohio Products Men Hold Their Annual Meeting

The Ohio Concrete Products Association held its annual meeting at the Gibson Hotel in Cincinnati, on February 14th, 15th and 16th.

The matter of building codes occupied perhaps the most prominent place on the program. Building commissioners of seven of Ohio's largest cities spoke at the first evening session on "Viewpoints of Building Commissioners." Ohio's state building regulations were discussed by F. Leo Smith of the board of building standards of Columbus.

Robert Smythe of the Portland Cement Association presented a paper on the subject of "Concrete Building Units." A discussion of "Graded Aggregate for Concrete Products," was the subject on which E. W. Dienhart of Cement City, Michigan, talked.

Selling Concrete Over the Counter

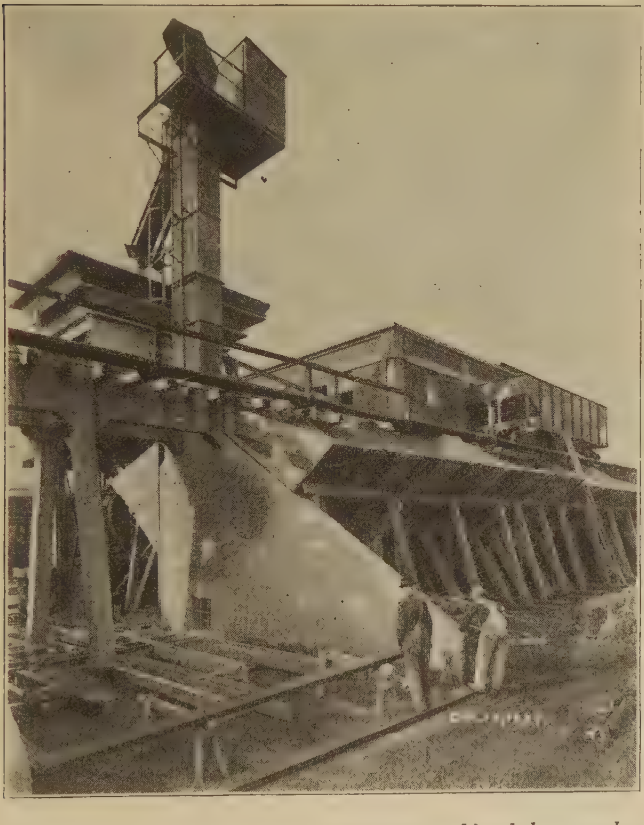
Richmond Central Mixing Plant Delivers Ready-Mixed Concrete for Six-Story Garage — Any Mix — Any Amount—Guaranteed Quality

IN Richmond, Virginia, there is now being successfully operated a modern central mixing plant for the commercial delivery of fresh concrete in any desired quantities within a radius of at least ten miles. It is located at 2018 W. Leigh Street and known as "The Ready Mixed Concrete Corporation."

Proportioning Materials

All concrete is mixed in a two-yard Ransome electric special mixer, all materials are carefully measured by weighing under inspection of an expert attendant constantly on the job. This enables the guarantee of any specified combination and consistency.

The sand is proportioned by a Blaw-Knox inundator which is equipped with scales for determining the gravel proportions. Arrangements are being made to store cement in bulk in overhead bins fitted with suitable weighing appliances.



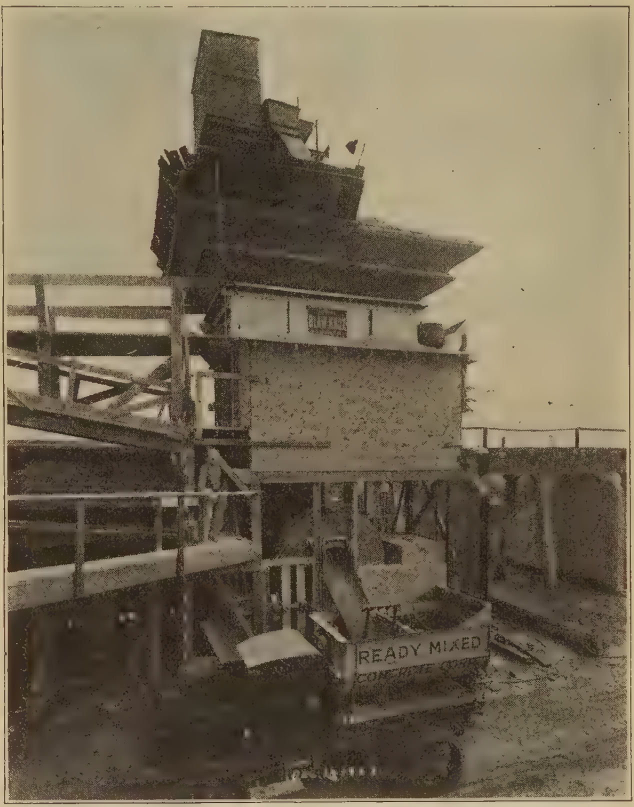
Storage bins above mixer and larger storage bins below trestle. Aggregates are conveyed from the larger bins to the smaller ones above the mixer by a conveyor and then fed to the measuring devices and on the mixer by gravity

Materials are delivered by cars on an inclined trestle and dropped to a belt conveyor passing to overhead storage bins from which they deposit the materials by gravity to the mixing machinery. After mixing for a period of one and one half minutes, the concrete is allowed to fall to waiting trucks underneath.

Delivery Equipment

The capacity of the plant is 600 cu. yds. per day or about 80 cu. yds. per hour. A fleet of six trucks are now in almost continual service. Each truck is equipped with a novel and efficient agitating device consisting of rotating metal blades that are geared to the motor transmission of the carrying truck and revolve slowly when the truck is under way.

The apparatus is an invention of Mr. O. T. Graham of Richmond and is being marketed under the name of Graham concrete agitator. They have a capacity of two and one half cu. yds. and so far as is known they are the only machines now being manufactured with a mechanical agitating device for a moving truck.



Truck for conveying concrete to job being loaded. This mixer, overhead bins, and the storage bins are also shown

Where Ready Mixed Concrete is Sold

There exists a rather wide range of demand for such premixed concrete; by owners who recognize that this will assure better concrete due to the careful control given and by builders on large and small jobs because of economies and efficiency.

Besides furnishing concrete for sidewalks, patch work, etc., the company is delivering all the concrete for the construction of the Richmond garage, a six-story, 130 by

164 ft. building at 6th and Franklin Streets, Lee Smith & Vandervort, architects and engineers. Three different proportions are being used on this modern structure, 1:2:4, 1:1½:3 and 1:1:2 slumps being uniformly maintained at about six inches.

Bins above mixer and apparatus for taking material from the large bins below trestle

The prices of fresh concrete at the job are $9.00 to $10.00 for 1:1½:3; $8.00 to $9.00 for 1:2:4; $7.00 to $8.00 for 1:3:6. At such prices it seems assured that a little figuring should convince a contractor that he could save money by patronizing the commercial plant. Where sand and gravel are hauled for any considerable distance it is probably cheaper to buy ready-mixed concrete as the hauling costs may be reduced.

Truck delivering concrete from central plant to six-story garage building. The concrete is dumped into a hopper from which it it is distributed to the forms

Tests on Ready-Mixed Concrete

A very careful series of experiments were conducted by Froehling & Robertson, testing engineers, Richmond, Virginia, as to the effects of slumps, strengths, etc., that accompanied the whole process. Specimens of concrete were taken from the mixer and at intervals of each mile up to 5.6 miles, the time of agitation ranging from one minute up to 47 minutes. Without exceptions the strengths were greater at the end of the run than at its beginning. Slumps were slightly less after the 47 minute period but the workable condition of the concrete seemed to be greatly improved, showing the beneficial effects of long agitation. The concrete as delivered on a job retains its cohesiveness without segregation and permits a desired workability condition with a drier consistency. Tests of standard 6-inch cylinders made on the garage job show compressive strengths of over 4000 lbs. per sq. in. for 1:1½:3 concrete at end of 28 days.

Plans are being made to furnish mortars as well as concrete and judging from the reaction of those who have used the premixed concrete it seems likely that within a short time the convenient central mixing plant will be on a well established business basis in almost all the larger towns.

Reinforced Concrete Repairs Damaged Steel Buildings in Miami

Liberal use of reinforced concrete was the principal feature in the reconstruction of the Meyer-Kiser Bank building and the repair of the Miami Realty Board building after the Florida hurricane of September 18, 1926.

The Meyer-Kiser Bank Building, originally a 17-story steel-framed structure, was so badly shattered and distorted that the owners deemed it best to reduce the reconstructed height to 7 stories. After the upper 10 stories had been removed it was found that the steel frame had sprung part way back toward its original position. The frame then was strengthened by encasing the columns and the wall girders in reinforced concrete. The concrete encasing was built plumb, but the embedded steel columns and girders were left in their distorted and out-of-center positions within the concrete.

The Miami Realty Board building as originally built had its wall girders encased in concrete, but the columns had not been so encased. The owner concluded that the concrete-encased wall girders were responsible for the better performance of the Realty Board building, inasmuch as the two structures were much alike in height and shape. Additional lateral rigidity was accordingly provided by constructing a well-braced reinforced concrete frame within the steel frame in the east or rear wall. This additional bracing extends from the ground story up to and including the eighth story.

The methods employed in repairing and strengthening the frames of these buildings are well justified in view of the increasing evidence of the superiority of the concrete-encased steel frame over the steel frame encased in tile units. A somewhat similar method was followed in repairing the steel-framed Maranouchi building in Tokyo after the Japanese earthquake of 1923. In that building the badly shattered brick fireproofing, exterior panel walls and interior cross walls were completely removed and replaced with reinforced concrete.

Concrete Strength from Aggregates of Unusual Grading

> ***In spite of the freakish gradings used, strengths were found to be reasonably close to the strengths shown on Abrams' curve.***
>
> ***The grading of the aggregates was found to be of minor importance in producing concrete of uniform strength.***
>
> ***Test results indicated that the grading of aggregates may be varied widely without producing corresponding variations in the relation of strength to water-cement ratio.***

By R. H. SHERLOCK

THE following experiment was undertaken for the purpose of studying the effect of unusual grading of the aggregates upon the strength of concrete mixtures, from the standpoint of the water ratio theory. It was not desired to check the Abrams curve, but to obtain the maximum possible variation from this curve which could be produced by using aggregates of freakish grading.

Test Procedure

Room dry aggregates were separated by a power screen into ten batches, each batch containing particles of the same size which had passed one screen of the standard A. S. T. M. series, and had been retained on the screen of the next smaller size. Various proportions of these different batches were then combined according to a previously prepared schedule, and mixed with a specified quantity of cement. The quantity of water used, together with the resulting slump, was recorded for each test cylinder. A separate batch of concrete was made for each test cylinder. The cylinders were made in groups of three with constant grading for each group.

A standard brand of portland cement was used which had been tested and passed by the laboratory of the Michigan State Highway Department. The sand and gravel was unwashed and was taken from a commercial pit near Ann Arbor. Before being separated, the sand particles varied in size from 0 to No. 4 and the gravel from No. 4 to 1½ inch in size.

The first six cylinders constituted control groups graded according to Fuller's "ideal curve." Cylinders No. 1, 2 and 3 contained 12½ per cent of cement by weight; No. 4, 5 and 6 contained 20 per cent of cement. The grading of the remaining 26 cylinders was kept as far from conventional gradings as possible, within the limits of the available screened material. The cylinders were capped with neat cement, stored in a moist room, and broken at the age of 28 days.

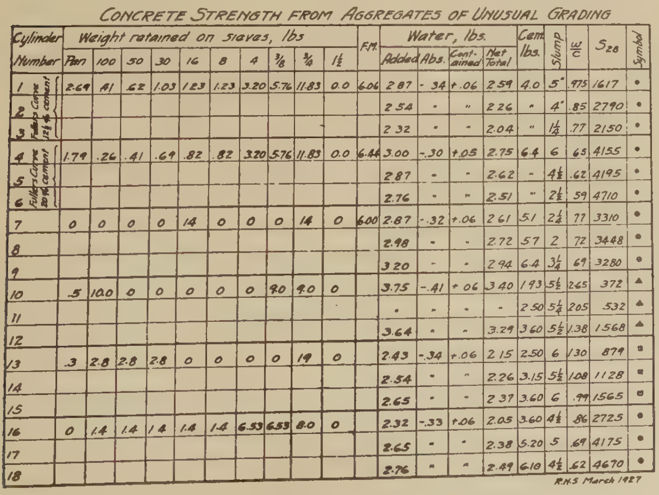
The moisture content of the aggregates was obtained by weighing samples before and after they had been dried over a Bunsen burner. It was found to be 16 per cent for the gravel, 15 per cent for the coarse sand (No. 50 to No. 8), and .2 per cent for the fine sand (retained on No. 100). A factor of .002 was used for sand and gravel.

The absorption factors were obtained by weighing samples of gravel and coarse sand which had been soaked in water for twenty-four hours and blotted, and by assuming a value for the fines. The absorption factors used were 1.1 per cent for the gravel, 1.2 per cent for the coarse sand, and 2 per cent for the fine sand. The water cement ratio was based upon the net water available for the hydration of the cement.

Test Results

The three accompanying diagrams show the results in tabular form, and also platted with Abrams' water ratio curve. Each cylinder is identified by a symbol, one symbol being used for the three cylinders of each group.

Four of the first six cylinders which are graded according to Fuller's curve lie close to Abrams' curve. Cylinders



CONCRETE STRENGTH FROM AGGREGATES OF UNUSUAL GRADING

Cylinder	Weight retained on sieves, lbs										F.M.	Water, lbs.				Cem lbs.	Slump	w/c	S_{28}	Symbol
Number	Pan	100	50	30	16	8	4	3/8	3/4	1½		Added	Abs.	Contained	Net Total					
1 Fuller's Curve 12½ % cement	2.69	.41	.62	1.03	1.23	1.23	3.20	5.76	11.83	0.0	6.06	2.87	-.34	+.06	2.59	4.0	5"	.975	1617	●
2												2.54	.	"	2.26	.	4"	.85	2790	●
3												2.32	.	-	2.04	"	1¼	.77	2150	●
4 Fuller's Curve 20 % cement	1.79	.26	.41	.69	.82	.82	3.20	5.76	11.83	0.0	6.44	3.00	-.30	+.05	2.75	6.4	6	65	4155	●
5												2.87	-	.	2.62	-	4½	.62	4195	●
6												2.76	.	"	2.51	"	2½	59	4710	●
7	0	0	0	0	14	0	0	0	14	0	6.00	2.87	-.32	+.06	2.61	5.1	2¼	77	3310	●
8												2.98	-	.	2.72	5.7	2	72	3448	●
9												3.20	-	.	2.94	6.4	3¼	69	3280	●
10	.5	10.0	0	0	0	0	0	9.0	9.0	0		3.75	-.41	+.06	3.40	1.93	5½	2.65	372	▲
11												.	-	.	-	2.50	5¼	2.05	532	▲
12												3.64	.	-	3.29	3.60	5½	1.38	1568	▲
13	.3	2.8	2.8	2.8	0	0	0	0	19	0		2.43	-.34	+.06	2.15	2.50	6	1.30	879	■
14												2.54	"	"	2.26	3.15	5½	1.08	1128	■
15												2.65	.	-	2.37	3.60	6	.99	1565	■
16	0	1.4	1.4	1.4	1.4	1.4	6.53	6.53	8.0	0		2.32	-.33	+.06	2.05	3.60	4½	.86	2725	●
17												2.65	-	.	2.38	5.20	5	.69	4175	●
18												2.76	"	"	2.49	6.10	4½	.62	4670	●

R.H.S March 1927

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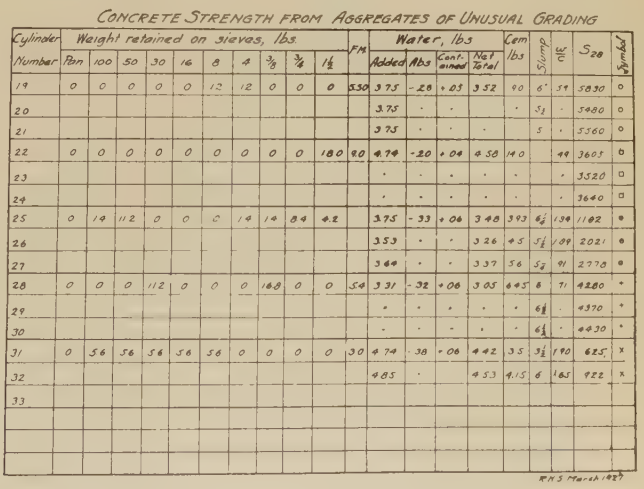

CONCRETE STRENGTH FROM AGGREGATES OF UNUSUAL GRADING

Cylinder	Weight retained on sieves, lbs.										FM	Water, lbs				Cem lbs	Slump	w/c	S_{28}	Symbol
Number	Pan	100	50	30	16	8	4	3/8	3/4	1½		Added	Abs	Contained	Net Total					
19	0	0	0	0	0	12	12	0	0	0	5.50	3.75	-.28	+.05	3.52	9.0	6"	.59	5830	○
20												3.75	.	.		.	5½	.	5480	○
21												3.75	.	.	.		5	.	5560	○
22	0	0	0	0	0	0	0	0	0	18.0	9.0	4.74	-.20	+.04	4.58	14.0		.49	3605	□
23												.	.	.	.	.		.	3520	□
24												.	.	.	.	.		.	3640	□
25	0	14	11.2	0	0	0	14	14	8.4	4.2		3.75	-.33	+.06	3.48	3.93	6¼	1.34	1182	●
26												3.53	.	.	3.26	4.5	5½	1.09	2021	●
27												3.64	.	.	3.37	5.6	5¾	.91	2778	●
28	0	0	0	11.2	0	0	0	16.8	0	0	5.4	3.31	-.32	+.06	3.05	6.45	6	.71	4280	+
29												.	.	.	.	.	6½	.	4370	+
30												.	.	-	.	.	6½	.	4430	+
31	0	5.6	5.6	5.6	5.6	5.6	0	0	0	0	3.0	4.74	-.38	+.06	4.42	3.5	3½	1.90	625	x
32												4.85	.		4.53	4.15	6	1.65	922	x
33																				

RHS March 1927

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No. 1 and 3 are 400 pounds per square inch and 950 pounds per square inch off the curve. No explanation is available for the erratic behavior of cylinder No. 1. The low slump shown by cylinder No. 3 when considered with a lean mix of 1:6.2 by volume, would indicate that the concrete should be classified as falling outside the zone of workable mixes. When handled with the trowel, this concrete seemed harsh and dry.

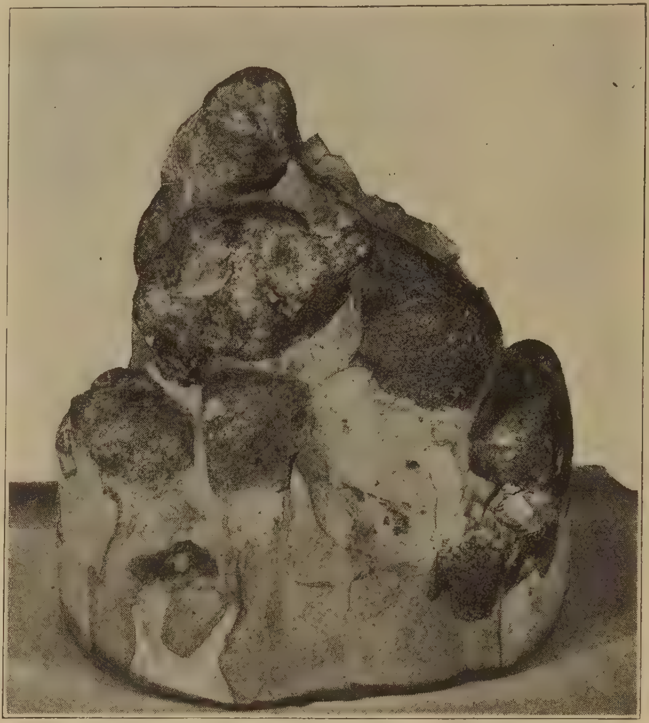
Cylinders No. 13, 14 and 15 fall 250 pounds per square inch, 550 pounds per square inch, and 450 pounds per square inch below the curve. No explanation is available, since the slump in each case indicates that the concrete was not too wet or too dry to be workable, and the grading is not more freakish than some of the other groups which gave strengths above the curve.

Cylinders No. 22, 23, and 24 fall about 1500 pounds per square inch below the curve. They were made of aggregate, all of which passed the two inch screen and was retained on a one and one-half inch screen. An examination of the broken cylinders shows that there was a tendency to split vertically due to the wedging action of the large stones, instead of the tendency to fail on surfaces of diagonal shear as is usually the case. This is shown in the accompanying photograph of cylinder No. 22. This same mixture might have shown better results in cylinders having a larger diameter than six inches.

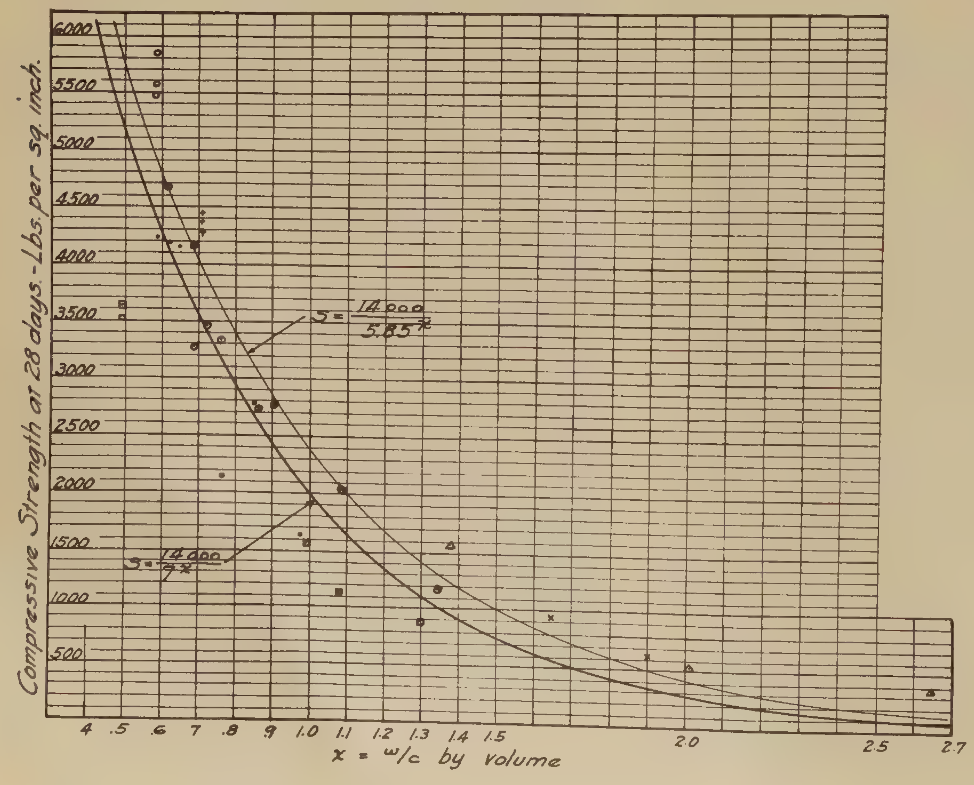
With the exception of the first six cylinders, the grading was in all cases so freakish that its unusual character could be easily determined by visual inspection without the aid of a sieve analysis. In cylinders No. 7 to No. 15, and No. 22, 23 and 24, there was a tendency for the coarse particles to segregate from the cement paste. For this reason, these gradings would be objectionable from a practical standpoint and would never be used on a job even where no specifications as to grading were being followed.

Conclusions

A considerable portion of the variability in the relation of strength to water ratio may be accounted for in the possible variations in the amount of absorbed water. Take cylinder No. 12 for example. If the absorption factor for the gravel had been increased from 1.1 per cent to 2.2 per cent, the water ratio would have been changed from 1.38 to 1.29, equivalent to a change in strength in this zone of more than 200 pounds per square inch. It is improbable that this degree of variation in the quality of the pebbles would occur from one group of



Cylinder No. 22, showing the tendency to split vertically



Test results platted with Abrams' water cement ratio curve cylinders to the next, but it is not impossible, because the gravel is made up of all classes of pebbles from impervious granite to porous sandstone and limestone. An unusual segregation of either class of pebbles would cause a wide variation in the amount of absorbed water and consequently in the resulting strength.

The fact that a fairly close approximation to the curve was obtained with only one specimen for each water-ratio, suggests the probability that some of the irregularities would have been smoothed out if each point represented the average of a number of cylinders.

In spite of the very freakish gradings which were used, it is seen by reference to Figure 1 that the points on the strength curve group themselves reasonably close to the Abrams curve and it may be concluded that the grading is of minor importance in producing concrete of uniform strength. Also, that the grading of concrete aggregates may be varied widely without producing corresponding variations in the relation of strength to water-cement ratio.

These tests were made in the laboratory of the Michigan State Highway Department at the University of Michigan, with the co-operation of Professor R. L. Morrison, director of the laboratory. All cylinders were made and tested under the personal direction of Mr. E. A. Boyd, superintendent of the laboratory, from the schedule and program prepared by Professor R. H. Sherlock.

Study of the Factors Governing the Strength of Concrete

The Bureau of Standards has completed a study of the variables entering into the fabrication of concrete, in which 3,000 cylinders were prepared and tested. The variables studied are as follows:

1. Quality of cement. Four brands of portland cement with different characteristics were used.
2. Gradation of the coarse aggregate. Eighteen gradings were studied.
3. Ratio of fine to coarse aggregate, four ratios being used.
4. Types of aggregates: Gravel, slag, and crushed limestone.
5. Age. The specimens were tested at six ages, namely, 1, 3, 7, and 28 days, and 3 and 12 months.
6. Proportions of mix. 1:1½:3, 1:2:4, 1:3:6 mixes were used in most part.

The specimens were removed from the molds at 24 hours and then placed in damp storage until tested. All concrete was made of such consistency as to develop a flow of 95 as measured by the flow table, using 15 one-eighth-inch drops. The following conclusions may be drawn from the results of the tests:

1. At the ages of 1, 3, 7, and 28 days the variations in quality of the cement produced marked differences in the strengths of the 1:2:4 concrete. At the 3-month age, however, the difference in strengths was 9 per cent in terms of the strength of the lowest one, and there was about 6 per cent at the age of 1 year.
2. The ratio of the strength of the concrete made from the four cements at 28 days varied from 1.96 to 2.76 of the strength at 7 days, under the conditions affecting this series of tests.
3. The proper ratio of fine to coarse aggregate for maximum strength depended on the type of the aggregate and its grading.
4. In most cases, when the coarse aggregate was deficient in one or two of the smaller sizes, that is, those varying between No. 4 to ⅜-inch and ⅜- to ¾-inch, a markedly better workability, together with very little change in strength, was obtained when using a mix in which the fine aggregate was 50 per cent of the total aggregate than when the fine aggregate was less than 33 1/3 per cent of the total aggregate.

Concrete Base Insures Life of Giant Oak Tree

Concrete is playing a major role in aiding in the preservation of hundreds of old trees throughout the country. An example of this tree life insurance with the aid of concrete is found at Chico, California, where the huge Hooker oak has many cement supports about its base for protection from winds and the natural ground dampness. These cement pillars and low blocks are serving to keep the lowest hanging limbs from resting on the ground and thus being exposed to decay. Cement has been used to fill decayed cavities in this tree.

This giant oak tree is over 1000 years old and has a spread of nearly 150 feet. The diameter of the trunk eight feet from the ground is nine feet.

The city realized the value of preserving this oak and set aside a large park for the public in which hundreds of other oaks were nearly as large as this Hooker oak. All the trees were doctored with cement and other means of preservation against destruction by the weather and elements.

Novel Concrete Coal Bunker Built in London

An interesting concrete structure which has just been completed in London is the 10,000-ton coal bunker built for the London County Council at its Greenwich power station. Its overall length is 340 feet, its width 30 feet, and its height 100 feet. While ordinarily a bunker of this capacity would offer no serious difficulty in construction, this was a case in which special requirements combined to render the task somewhat more difficult.

It was necessary that the foundations should be constructed in workshops, mess rooms, lavatories and other buildings without interfering with the use of such rooms. Again, the bunker was to be designed without internal obstructions to the flow of coal. The former difficulty was overcome without resorting to unsymmetrical spacing of the supporting columns, while the latter condition was met by making the bottom of the bunker parabolic in shape, the construction comprising sufficient steel reinforcement to take the whole of the stresses due to the weight and pressure, concrete being used merely as a covering for the steel reinforcement. The wide variety of the problems which have from time to time to be solved in concrete construction is well illustrated in the case of this and similar unusual types of buildings.

How Concrete Products Are Sold in Juneau, Alaska

An Enterprising Products Manufacturer Located in Alaska Sells His Output Successfully

A MERCHANDISING campaign in Alaska! And for concrete products at that! The concrete products maker in New Jersey, in Iowa, in California, may have his merchandising problems, but he can look to his fellow manufacturer located in Alaska for sales ideas.

In Juneau, Alaska, is located the Concrete Products Manufacturing Company, "Agents for Cement Molds" and "Concrete Waterproof Engineers." G. Fagerson is the manager. Ink from Mr. Fagerson's pen shapes the firm's merchandising efforts in an advertising way. On this page are reproduced several pieces of the sales literature.

An abstract of one of the form letters that Mr. Fagerson is distributing as a part of his campaign reads:

11 BIG REASONS

WHY YOU SHOULD BUILD THE HOLLOW-WALL WAY

FIREPROOF.—Concrete is the most fireproof building material known, so why not use it? An ounce of prevention is worth a pound of cure. You insure your buildings against loss by fire, but why not erect them out of material that will not burn?

WEATHER-PROOF.—Interior of building is always dry regardless of weather conditions.

FROST AND MOISTURE-PROOF.—Heat, cold or moisture will not penetrate the 2¼-inch dead air-space, but any capilary attraction will be absorbed by the solid outside Concrete Wall.

EASILY FINISHED.—Plaster or stucco will not crack or peel when applied directly to the newly built Concrete, with only half the amount of plaster required, as no lath is used and therefore less labor.

SANITARY.—Extensive use of concrete will eliminate insects, rats, vermin; hence promote good health and save doctors' and medicine bills.

EVERLASTING.—Concrete will never wear out, rust, burn or decay; it will, on the other hand, take on a patina of age, and so require no paint.

OF THERMOS BOTTLE PRINCIPLE.—Cooler in hot weather, warmer in cold, a half less fuel required, likewise no insurance, and with utmost comfort.

ATTRACTIVE.—Any style house can be built with this plastic material, from the tiniest buangalow to the mansion grand.

NEVER NEED TO BE PAINTED.—As the house grows older it will take on a patina of age, and therefore will look in harmony with surroundings.

ECONOMICAL.—All unnecessary handling of material done away with; you do not have to erect shorings and tear them down again after the wall is completed, thereby saving both labor and material.

EASILY OPERATED —You do not need a skilled mechanic to operate the molds, as any one with ordinary intelligence can handle them successfully.

Our molds will do all for you we have previously stated and give you a 2¼-inch dead air-space all the way around your building, uninterrupted by anything that is conductive of heat or cold, as well as moisture.

Concrete Products Mfg. Co.
JUNEAU, ALASKA

PERMANENT

WITH THE UNIVERSAL CEMENT MOLDS

BUILD THE HOLLOW WALL WAY—LIKE A THERMOS BOTTLE—WARMEST IN WINTER, COOLEST IN SUMMER

Fire-Proof, Everlasting—Best, Cheapest and Most Perfect Way Known to the Building World.

COMPARISON OF COST FOR EACH METHOD:

To construct 100 square foot finished double wall (composed of two 3½-inch walls with a two-inch air-space between them) requires:

2½ yds. sand and gravel, at $4.00	$10.00
3 bbls. of cement at $6.00	18.00
11 1-9 yds. rough cast applied to wall	4.00
11 1-9 yds. plaster (no lath required)	9.00
Wall ties and reinforcing steel	2.00
Labor	15.00
Total (not including any profit)	$58.00

To construct 100 square foot finished wall of wood requires

10 pieces 2x4x10, or 70 ft at $35 per M.	$ 2.35
120 ft. 6-inch D. and M. sheeting, at $35.00 per M.	4.20
124 ft. 6-inch siding, at $65.00 per M.	8.00
105 ft. building paper, nails	2.00
Paint and painting	15.00
Carpenter work	20.00
11 1-9 yds. lath and plaster	17.00
Total (not including any profit)	$68.55

The difference between $58.00 and $68.55 is $10.55 per each 100 square feet of wall in favor of our method of construction.

Do not think because our method is cheapest, that it is not best Double monolith walls, built with our forms constitute a house within a house, which is positively the best known method of building.

One cubic yard of sand and gravel and one barrel of cement make 22 cubic feet of concrete. It will build 22 square feet of double 6-inch wall; 33 square feet of double 4-inch wall; 38 square feet of double 3½-inch wall, etc., with our method, because intelligence gives the Hollow Wall Way the preference.

The difference in cost will pay for one set of forms on the first job, and one set with reasonable care will last a life time.

CONCRETE PRODUCTS MFG. CO.

JUNEAU, ALASKA

Phone 32 **P. O. Box 144**

"The best proof we have that our products are better and most durable is that our business is each year showing an increase over the preceding one.

"Following are the four general requirements for making A-1 concrete: Selection of proper aggregates; using the proper amount of water; method of selecting the mix, and proper curing. These are the four most vital requisites we follow strictly to the letter, and herein lies the secret of our success.

"A cream-colored stucco with specially trowelled surface on the concrete hollow wall forms a most harmonious background for shrubbery and flowers, porch columns, balustrades and caps, together with steps, all ornamented to harmonize with broken flagstones set with red mortar joints in all walks.

"Artistic achievements such as the above mentioned are possible in every city in Alaska, as well as in the country districts, at no additional first cost over wood construction of similar size and design."

On the letter also are reproduced illustrations of the molds.

Mixer Musings

Reported by "Joe"—The Mixer Boss.

The Strange Case of the Lost Cone

By J. S. LAIN, C.S.T.

(With Apologies to Sir Arthur Conan Doyle)

(Continued from the February issue)

"It was this way," he continued, "At first I thought it was the work of a scofflaw or 'pitylacker' until I remembered that this unusual case showed many points of similarity with the case of the Highway Engineer and the missing Lateral Reinforcement. Both had laid down their insignia whilst looking for something else, (you remember the engineer had just laid down his Modulus of Rupture and was looking for a Coefficient of Expansion) when the blow fell.

"So I disguised myself as a concrete laborer, and went to the scene of the crime. It is years since I have seen a winter job. The first thing that struck me as strange was the fact that the skeleton of the building was enclosed with tarpaulins. This was a significant fact that would have been overlooked by the usual investigators. To get to the bottom of this, I questioned the foreman, whom I found to be a Scotchman. He told me it was 'to keep the heat in.'

"Now, as you know, my dear Watson, in my thesis, 'Inner Forces in Monolithic Homogeneous Beams and Spandrels,' I state that 'the chemical action of the hydration of the finely pulverized product does not increase the temperature of the intimately proportioned batch more than a few degrees.' It was obvious, therefore, that for some reason I was being put off the track.

"My next move was to get a job on the building, which I speedily did, being put on the mixer gang. During the course of the morning (there was no time to be lost, my dear Watson, for even then the cone might have been on its way out of the country) I broached the subject of the tarpaulins to the mixer boss, who was a talkative fellow (as all mixer bosses are). He told me the same thing that the foreman did, 'to keep the heat in.' Strange, indeed, is it not? Thinking there was some flaw in my disguise, and that I was purposely being misled, I was determined to find out for myself what lay behind the tarpaulins.

"As I neared the enclosure, I was aware of the absence of any noise, and creeping nearer, slipped under cover. Picture to yourself my surprise in finding several fires there all alight, heating up the concrete. On recovering myself, the first thing that struck me was the difference in size of the fires. Some were big fires and others were small fires and the one that particularly drew my attention was a very small fire right in the center, scarcely more than (if as much as) a foot high and a half a foot wide. Drawing closer to the nearest fire I saw that the coals were in an old oil drum, the next in an old calcium drum and the fire in the center was in the cone you now hold in your hands."

"Wonderful, marvelous, my dear Duff," I said, "But what made you so inquisitive about what was under the tarpaulins?"

"Why a Scotch foreman," smiled Duff, "They would take any can to save a muckle. He doubtless little realized the awful significance of a truncated cone, and took it for an old can."

Joe, the Mixer Boss.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit, Michigan.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 W. Grand Ave., Chicago.

American Construction Council; Dwight L. Hoopingarner, Executive, 28 W. 44th St., New York City.

American Engineering Standards Committee; Dr. P. G. Agnew, Secretary, 29 W. Thirty-ninth St., New York City.

American Road Builders' Association; Miss E. A. Birchland, Secretary, 29 W. Thirty-ninth St., New York City.

American Society of Civil Engineers; Geo. T. Seabury, Secretary, 33 W. Thirty-ninth St., New York City.

American Society for Testing Materials; C. L. Warwick, Secretary-Treasurer, Engineers' Club Building, 1315 Spruce St., Philadelphia, Pa.

Associated General Contractors of America; D. H. Sawyer, Secretary, 1150 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 W. Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference of America; H. E. Plummer, President; Fred W. Lumis, City Hall, Springfield, Mass., Secretary.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, Tribune Tower, Chicago.
Fourth annual meeting, Edgewater Gulf Hotel, Biloxi, Mississippi, March 19th to 21st.

Concrete Products Association; S. I. Crew, President, Norwood, Ohio; Austin Crabbs, Secretary, Box 343, Davenport, Iowa.

Iowa Concrete Products Association; Floyd Goodrich, President; R. L. Gavin, Secretary-Treasurer, 405 Hubbell Bldg., Des Moines, Iowa.

National Association of Building Trades Employers; A. E. Coleman, President; A. W. Dickson, Executive Secretary, 2226 Builders Building, Chicago, Ill.

National Association of Builders' Exchanges; William F. Chew, Baltimore, President; Earl F. Stokes, Secretary, 15 E. Fayette St., Baltimore, Md.

National Crushed Stone Association; J. R. Boyd, Secretary, 751 Earle Building, Washington, D. C.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 E. Twenty-second St., New York City.

The National Lime Association; G. B. Arthur, Secretary, 927 Fifteenth St., N.W., Washington, D. C.

National Slag Association; H. J. Love, Secretary-Treasurer, 933 Leader-News Building, Cleveland, Ohio.

National Sand and Gravel Association; V. P. Ahearn, Executive Secretary, 432 Munsey Building, Washington, D. C.

Nebraska Concrete Products Association; Frank Whipperman, President, Omaha, Nebr.; Roger L. Merritt, 26th and Randolph St., Lincoln, Nebr.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High St., Columbus, Ohio.

Portland Cement Association; William M. Kinney, General Manager, 33 W. Grand Ave., Chicago.

Rail Steel Bar Association; H. P. Bigler, Engineering Secretary, Builders' Building, 228 N. La Salle St., Chicago, Ill.

Wisconsin Concrete Products Association; E. B. Bushnell, Secretary-Treasurer, 425 E. Water St., Milwaukee, Wisconsin.

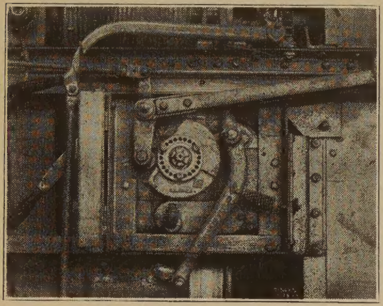
New Equipment and Materials

Chain Belt Introduces "Mechanical Man"

The "Mechanical Man" made his appearance in the Chain Belt Company booth at the Cleveland road show in January and for those who are not yet acquainted with this paver development, the following is published.

The "Mechanical Man" is a simple mechanism making possible the automatic high-speed operation of the 1928 Rex paver. The manufacturers claim that the Rex operator is relieved of over 2,000 manual operations in a day's run.

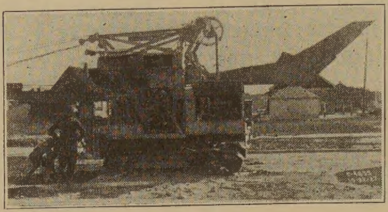
The manufacturers say also that the dribble in discharging occurring at the last end of the batch results in the separation of concrete which is noticeable when discharging the last few feet of concrete from the drum. Shutting off the discharge at the end of the 8 or 10 seconds eliminates this dribble and prevents the separation of the fine and coarse aggregates at the last end of the discharge.



The Rex "Mechanical Man" regulates and controls the discharging action. It discharges batches of uniformly mixed concrete in 8 seconds by automatically shutting off the discharge at the end of a fixed period, and carrying over a constant amount of concrete into the next batch.

Field tests are said to show that the action of the Rex "Mechanical Man" in shutting off the discharge in 8 seconds insures the discharge of a fixed amount of concrete equal to the amount which is added in each successive batch. In other words, the Rex automatic 8-second discharge clears the drum and prevents any accumulation or building up of the concrete in the drum beyond the amount normally carried over and remixed with each succeeding batch. This holds true when mixing any size batch which can be handled in the 27-E Rex, or when mixing the concrete to any desired consistency.

These field tests show that with sufficient concrete in the drum to permit the buckets to carry full during the entire discharge period, the Rex 27-E will discharge approximately 35 cubic feet of mixed concrete in 8 seconds.



The Chain Belt Company of Milwaukee, Wisconsin, is the manufacturer.

New Plain Form Tie Fits Any Size Stud

Among the form specialties on the market is the new Sure Grip plain tie, made to fit any size stud and sheathing board, from 2 by 4's to 4 by 6's. Its use is recommended where no reinforcing steel is encountered and where both inner and outer forms can be built at the same time.

It is claimed that wire flattened at sheathing board sections reduces cracking between boards to the minimum and that channel and straight tips, securely riveted on the tie, cannot turn in operation.

A plate is set and studs are placed every three or four feet, O. C. staggered so that the spacing of the tie on the boards is every one and one-half or two feet. The loop end of the tie is placed around each stud and over the board. The tip end drops on the opposite side of the board. The next board is then dropped in position and the operation repeated.

The Dayton Sure Grip and Shore Company, Dayton, Ohio, manufacture the tie.

Lewis-Shepard Products Plant Equipment Has New Improvements

Three announcements of interest regarding its material handling equipment have been made by the Lewis-Shepard Company, Watertown Station, Boston, Massachusetts. The announcement concerns improvements that are now found as a part of all Lewis-Shepard lift trucks and stackers, as follows: a lifting radius of 180 degrees on lift trucks, eliminating horizontal release checks and making possible gentle lowering of loads; a "cable control" for safety on all power type stackers, and on hand power stackers, a special attachment known as the "decelerator," to insure the slow lowering of loads under ordinary and emergency conditions.

Union Building Specialties

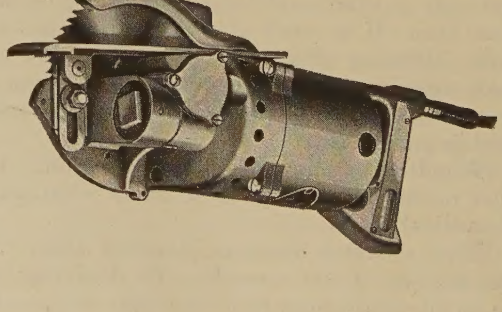
There is available a line of reinforced concrete building specialties that is complete enough to include a good many of the items used in erecting form work particularly. It includes continuous column ties, continuous chair stirrup units for beams and joists, joist and beam bar spacers, continuous anchor slots, hi-chairs, and sleeper spacing anchors, all known as "Union" products. "Xact" form spacers and Reed soffit clips are also included.

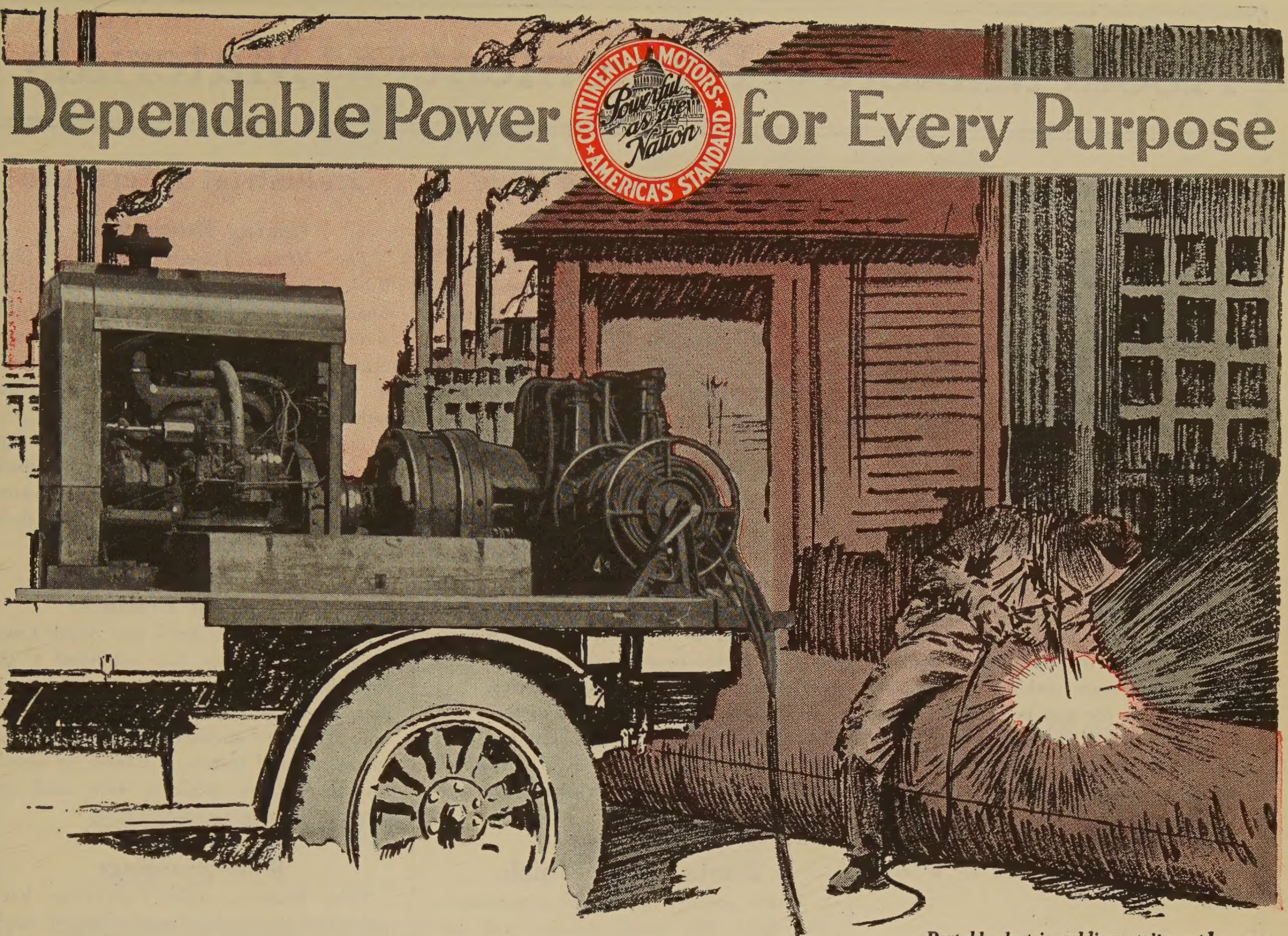
All items are manufactured by the Union Steel Products Company, Albion, Michigan.

Junior Skilsaw Perfected

An 11-pound electric hand saw, developing ½ horsepower, has been designed and placed on the market by Skilsaw, Incorporated, Chicago, Illinois. This junior Skilsaw, known as Model J, is designed to cut 2-inch dressed lumber. It may be used in either hand, in any position, with ease.

The manufacturers emphasize the fact that the saw is economical in operation, fast, and safe, as well as productive of smooth, accurate sawing.





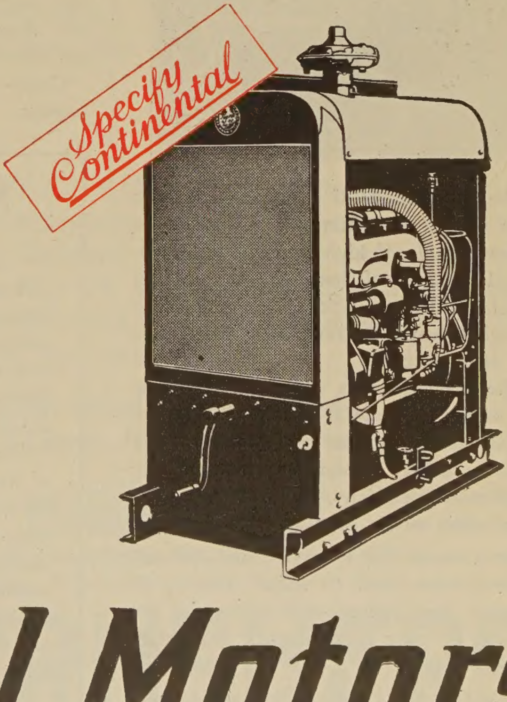
Portable electric welding equipment has won a new measure of confidence and adaptability since the efficient, dependable characteristics of Red Seal Continental motors have been combined in rugged, compact power units especially designed for this service.

The Peaks of Industry

Running along on peak production, day after day, calls for equipment which stands the strain without a falter.

Heavy duty Red Seal Continental motors furnish thousands of varying industries with a type of economical gasoline power which speeds up production and cuts manufacturing costs. In these varied fields Continental serves with a dependability which is the result of a specialized knowledge of power plant needs plus a quarter century's experience in developing such equipment for specific uses.

CONTINENTAL MOTORS CORPORATION
INDUSTRIAL EQUIPMENT DIVISION
Office and Factory: Muskegon, Michigan
The Largest Exclusive Motor Manufacturer in the World



Continental Motors

Index to Advertisements on Page 5

About Makers of Equipment and Materials

New Equipment

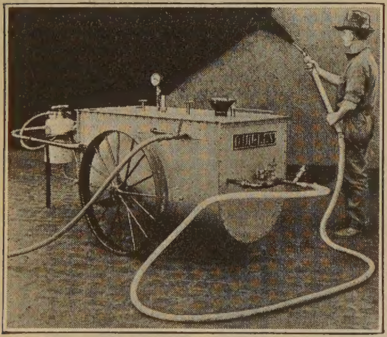
(Continued)

New Spray Gun Shoots Hot Liquids of All Kinds

For applying hot tar, asphalt, enamels, heavy fluids, waxes and similar materials, by means other than the mop and pail method, there has been developed a gun said to be capable of spraying or shooting liquids of almost any thickness or temperature through insulated, metallic hose distances up to several hundred feet from the gun.

For hot spraying, the preheated material is put into the gun through a charging opening. The vent is closed by a quick-acting valve and the opening of another admits air pressure behind the piston. Temperature in the gun is regulated by a small self-contained kerosene burner. A large scale thermometer is in constant sight of the operator.

After the gun has been completely discharged, compressed air sends the piston back to the loading position for a fresh charge.



The gun consists of a cast iron cylinder from which the material is forced by a piston capable of high pressure. It is enclosed in a steel housing, mounted on wheels, with a capacity of 15 gallons or enough to cover approximately 400 square feet of surface.

The manufacturers state that 15 cubic feet of air a minute at 60 pounds pressure is sufficient to operate the gun. A small portable garage compressor, operated by gasoline or electricity, will serve the purpose where no air supply is available.

On a recent job it is said that the gun covered more than 60 square feet in 20 seconds. Five gallons were sprayed in one minute, covering approximately 125 square feet.

The Quigley Furnace Specialties Company, New York City, is the manufacturer.

Notes from the Field

Cal Removal

The *Cal* division of the *North American Cement Corporation* is removing its headquarters on March 1st from Hagerstown, Maryland, to the general sales offices of the corporation at 285 Madison Avenue, New York City. *R. H. Catlett,* manager of the *Cal* division, will be transferred to New York in his present capacity.

Cementation Process

The Dravo Contracting Company, Pittsburgh, Pennsylvania, has arranged with European interests to use the process of cementation, the injection under high pressure of liquid cement mixtures into cavities, fissures and cracks, in America.

The process is the property of the *Francois Cementation Company,* England, and its representative, *Major J. S. Crawhall,* has joined the staff of the *Dravo Contracting Company.*

Zonta Wall Finish

A new product applied as a permanent wall finish that stands cleaning well and is known as Zonta, is described in Bulletin 1 issued by the Zonta Corporation, Washington, D. C. The bulletin is a 6-page folder telling how Zonta may be applied directly over the brown coat without sizing and may be glazed. Popular textures that may be developed with the material are shown. Photographs of installations are also shown.

Copies of the bulletin are supplied upon request.

Industrial Literature

Caging Estimations

The Mitchell-Tappen Company, New York City, has announced as available upon request a bulletin that is a helpful reference folder on standardized metal caging for fireproofing. The data contained in it is said to be new and hitherto unpublished.

Tables are given for estimating the caging required for channels, columns, haunch stiffeners, and beams. Diagrams showing their application and illustrations of their use accompany the data.

Sure Grip Products

The Dayton Sure Grip and Shore Company, Dayton, Ohio, has published a 16-page booklet embracing *Sure Grip* products, such as adjustable shores, sleeper and furring anchors, wall ties and spreaders, and inserts. Instances in which several of these products were used are shown.

Waterproofings

Toch Brothers, New York City, have published in handy shape a set of engineers' and architects' specifications embracing *"R. I. W."* technical paints and waterproofing compounds. These are in loose leaf form, enveloped by a folder, one sheet being devoted to each product. They may be filed separately, according to the A. I. A. method, or in the folder.

Specifications are fairly brief, but comprehensive. Accompanying each specification is an outline of the character of each material.

Molds for Buried Garbage Receptacle Make Appearance

A somewhat different idea in residential concrete garbage receptacles has been worked out by the R & L Concrete Machinery Company, Kendallville, Indiana. Molds for this concrete products specialty are now available.

The receptacle is round, about the size of the standard galvanized can and is buried in the ground to the level of the cast iron lid. It is fitted with a galvanized can having a handle to make removal of rubbish feasible.

Molds are purchased outright, involving no royalties. Castings and cans may be secured from the mold manufacturer.